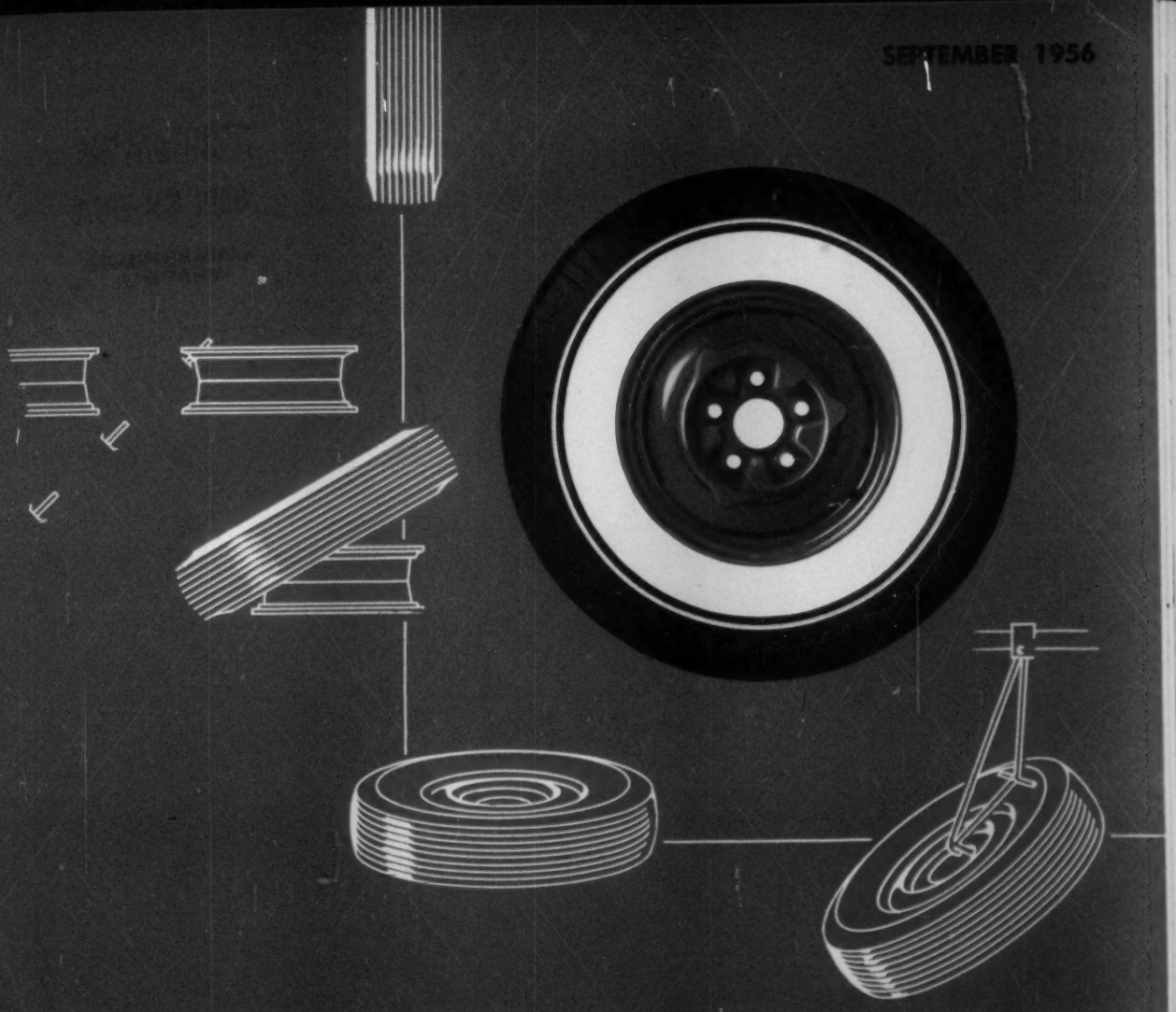
AUTOMATION

SEPTEMBER 1956



CONTINUOUS LINE SPEEDS

Auto Wheel Assembly

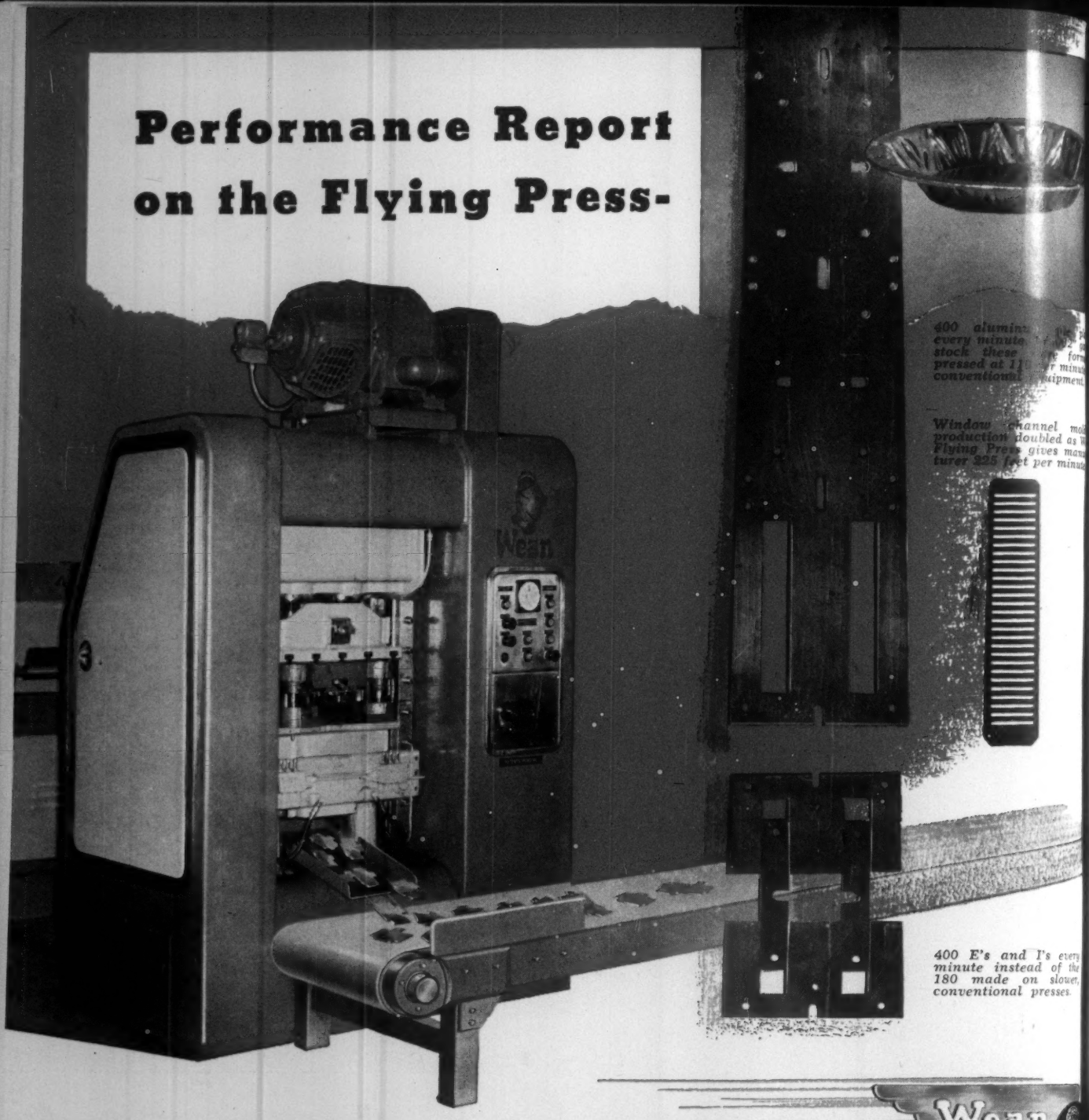
The Magazine of Automatic Operations

- Pneumatics for Process Control
- Packaging Dry Food Products
- Automatic Balancing
- Controlling pH of Process Solution

CONTENTS — PAGE 2

A PENTON PUBLICATION

Performance Report on the Flying Press-



400 alumin... every minute ... stock these ... form... pressed at 1... r minu... conventional ... uipment.

Window channel ma... production doubled as ... Flying Press gives manu... turer 225 feet per minu...

400 E's and I's every minute instead of the 180 made on slower, conventional presses.

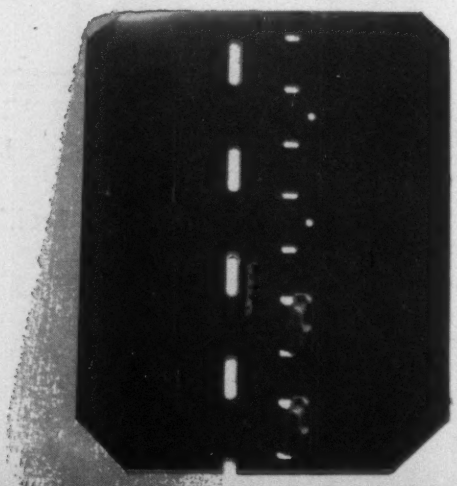
Revolutionary Wean Press continues to amaze the industry

Since it was first introduced to industry, the Wean Flying Press has commanded the interest of imaginative production people.

On paper, it looked good. Tests on the hand made prototype were even more convincing. But, could a production model achieve such levels under actual operating conditions?

For the answer—note the typical production figures set down here. In every case, the Wean Flying Press, using standard die sets, has established a performance record.

Why not acquaint yourself with this amazing press now? Contact the Wean Sales-Engineer in your area or write direct.



Shallow draw a... punch work on .0... gauge stock boost... to 400 pieces p... minute by Wea... Flying Press.

Wean

EQUIPMENT CORPORATION

CLEVELAND • CHICAGO • DETROIT • NEWARK, N. J.

Cable WEANCOR

Circle 551 on Inquiry Card

SEPTEMBER 1956
Vol. 3—No. 9

AUTOMATION®

THE MAGAZINE OF AUTOMATIC OPERATIONS

ROGER W. BOLZ, Editor

EDITORIAL STAFF

JAMES C. KEEBLER, Associate Editor
WILBUR R. ELLIS, Associate Editor
JOHN H. McRAINEY, Assistant Editor
LEE D. MILLER, Assistant Editor
FLEUR W. METZGER, Assistant Editor
HELEN M. VERESPY, Editorial Assistant
EDWARD D. KARL, Art Editor

REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Meetings and Events, 12
Reader's Reply Card, 17
Detroit Dateline, 33
New Equipment, 83
New Components, 104
New Literature, 124
New Books, 128
Patents, 129
Abstracts, 130
Management and Numerical Control
Industry Needs Automation
Editorial Index, 136

It's Not Automatic, 39
EDITORIAL—top management understanding and program coordination are requirements for successful automation.

Auto Wheel Assembly, 40
H. R. GREENLEY and W. E. SCOLLARD—system assembles wheels, valves and tires, and delivers them to final assembly.

Packaging Dry Food Products, 46
KEITH H. REDNER—AUTOMATION TODAY—continuous flow packaging line in a plant manufacturing breakfast foods.

Synchronizing Sensing and Processing, 49
A. S. BURGOYNE—electromechanical devices automatically delay information signals from earlier points of a line.

Pneumatics for Process Control, 54
A. JAMES WALDRON—weighing the relative advantages of pneumatic and electronic instruments in control systems.

Versatile Transfer Machine, 64
VARIETY PRODUCTION—pallet-type fixtures have interchangeable parts to handle gate and globe valve bodies.

Remote Control Signals, 66
COMMUNICATION MEDIA—system enables voice frequency circuits to carry control and data reporting signals.

Thermally Sensitive Resistors, 68
ELECTRIC ELEMENT—thermistor's negative temperature coefficient of resistance links temperature, current and time.

Heavy Duty Conveying, 70
STONE HANDLING—quarry to crusher to storage yard proves value of antifriction bearings for low maintenance.

Automatic Balancing, 71
CLIFFORD LANDSNESS—machines equipped for automatic handling measure unbalance, correct and inspect parts.

Controlling pH of Process Solutions, 78
J. B. MOHLER—components and systems of instrumentation for measurement and control of this process variable.

Industry Views, 14
INTEGRATED PACKAGING AND INSTRUMENT CONTROL—comments by recognized experts in both automation areas.

automation outlook

VAST NEW FIELD

". . . let's call it automation—this new frontier we're talking about. Briefly, it means doing things automatically that used to be done by hand or by manual supervision. Production-wise, it opens a vast new field for making substantial cost savings and at the same time improving the quality of the product. In the machine tool field, we might say that there are two different types of automation—both mighty important.

"First, there's the big automation. That covers the completely automated setups involving a number of machine stations, with fully automatic handling of the work as it goes down the line. For large parts, we have the so-called transfer machine, where the work advances from one station to the next in series. For smaller work that can be conveyor or hopper fed, an automated production line may consist of a multiplicity of stations, each made up of as many identical machines as are needed to equalize production flow throughout the line. We have a two-unit setup where automotive pistons are bored and elliptical box turned in a continuous flow with automatic conveying, orienting, loading, borizing, unloading, flushing, gaging and sorting.

"Second, there's the little automation. This covers newly automated features of an idividual machine. A classic example of this is feedback—where the finished work is gaged and intelligence from the gaging unit is fed back to the machine, automatically compensating for tool or wheel wear. Feedback means less operator effort and attention—assures maximum sustained efficiency of the overall automated production setup. You'll hear much more of this as time goes on . . ."—*A. Francis Townsend, vice president-engineering, Heald Machine Co.*

INSTRUMENTS IN AUTOMATION

". . . industry today has become well aware of the part control instruments play in automation, and this part has even been recognized in a slogan, "Instrumentation Paces Automation". A new trend in instrumentation is taking place, however, in which automation is being applied to the instruments themselves, and we now find situations where one instrument is controlling another in its actions . . ."—*D. C. Sanford, manager, application engineering department, The Bristol Co.*

TREMENDOUS FLOWERING

". . . automatic mechanization is in principle the marriage of two or more of the following: Motion, machining, measurement and memory, if we think of motion as including both the transferring of parts and information. And we are witnessing a tremendous flowering of such automatic mechanization . . ."—*Louis Polk, president, Sheffield Corp. and president, National Machine Tool Builders' Association.*

TIMELESS ADVICE

". . . it is possible, however, to offer more timeless advice. Beware of generalizations such as: One system's installed cost is lower than the other; one system's panel will be the cheaper to install; and the maintenance and downtime of one is better than the other, is more versatile, more compatible with future trends, etc. The only conclusion to be reached now is this: Each process or plant is a case unto itself, a case for rational study by competent, impartial persons familiar with all aspects of both the pneumatic and electronic systems . . ."—*A. James Waldron, principal instrument engineer, Catalytic Construction Co.* *See page 54.*

AUTOMATION

Penton Building, Cleveland 13, Ohio

Main 1-8260

R. C. JAENKE
Business Manager

BUSINESS STAFF

ELIZABETH ROOT, *Advertising Service Mgr.*

J. M. CASTIGLIONE, *Production Mgr.*

S. F. MARINO, *Research & Promotion Mgr.*

JACK C. GERNHARD, *Circulation Mgr.*

D. C. KIEFER, *Marketing Director*

AMY LOMBARDO, *Directory & List Dept.*

JUNE SCHILENS, *Reprints*

Advertising Representatives

New York 17 . . . . . 60 East 42nd St.
EDWARD S. LAWSON, FRED A. STANLEY
Murray Hill 2-2581

Cleveland 13 . . . . . Penton Building
LARRY D. BRENNAN, ROBERT S. MADDOX
Main 1-8260

Chicago 11 . . . . . 520 North Michigan Ave.
RICHARD W. JONES, RAYMUND A. GROSS
Whitehall 4-1234

Detroit 35 . . . . . 15800 West McNichols Rd.
LARRY D. BRENNAN
Broadway 3-8150

Los Angeles 57 . . . . . 2330 West Third St.
The Robert W. Walker Co.
ROBERT W. WALKER, CHARLES F. MEISTER
Dunkirk 7-4388

San Francisco 4 . . . . . 57 Post St.
The Robert W. Walker Co.
ROGERS PARRATT, JOSEPH KELLER
Sutter 1-5568

Griffin, Ga. . . . . 1106 Pine Valley Rd.
FRED J. ALLEN
Griffin 7854

London, S.W. 1 . . . . . 2 Caxton St., Westminster

Published by

THE PENTON PUBLISHING COMPANY

G. O. HAYS . . . . . *President*
R. C. JAENKE . . . . . *Executive Vice President*
F. G. STEINEBACH . . . . *Vice Pres. and Secretary*
F. O. RICE . . . . . *Vice President*
J. P. LIPKA . . . . . *Treasurer and Asst. Secy.*

Also Publisher of
STEEL • FOUNDRY • MACHINE DESIGN
NEW EQUIPMENT DIGEST

Published monthly. Subscription in the United States, possessions, and Canada: One year $10. Single copies, $1.00. Other countries one year, $20. Copyright 1956 by The Penton Publishing Company. Accepted as Controlled Circulation Publication at Cleveland, Ohio.

BPA NBP

Circle 556 on Inquiry Card→

AUTOMATION news

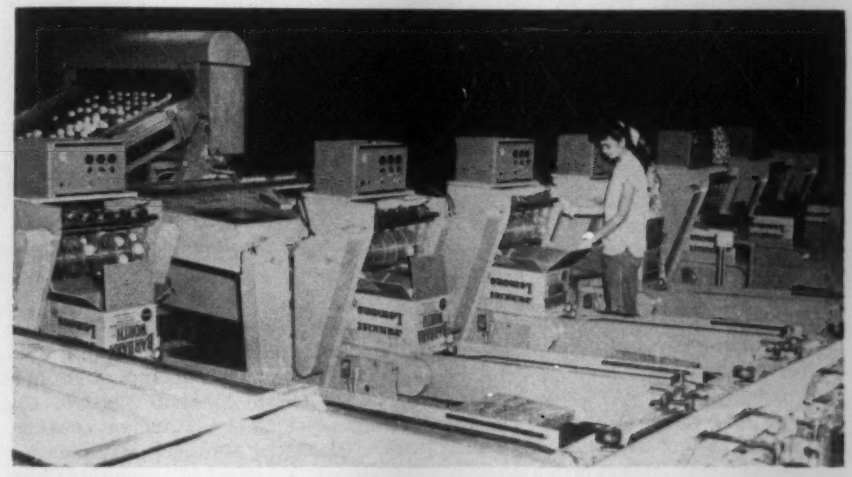
Today's events and developments in the field of automation

New Moisture Controller For Free Flowing Solids

DEVELOPED by the Mechanical & Electronic Products Div., Quaker Oats Co., new moisture controller can measure, indicate, record and control moisture content of free flowing solids on a continuous basis. The unit has been tested commercially on corn products, hominy grits, whole grains, rolled oats, dry dog food, whole corn flour and commercial mashes. Laboratory installations have been run on tobacco, fertilizer and other free flowing solids of consistent particle sizes.

The Rogers moisture controller consists of a forced feed test cell and a recorder-controller. It works on the basis of cutting out a small portion of a main stream of free flowing material. In a mill, for example, approximately 5 per cent of the stream might be cut out and sent through the test cell at a rate from 100 to 200 lb per hour. In the test cell, the stream is forced between electrode plates which measure the dielectric effect by capacitance reactance. Product is then conveyed back to the main stream with no loss or damage.

The recorder-controller element may be a Fielden capacitance bridge which can be installed remotely from the test cell, convenient for reading, changing charts, or servicing. Very accurate control of moisture variance is possible. In general, the narrower the range of particle size, the higher the accuracy. For example, moisture content of one material classified between No. 16 and No. 20 wire screens can be measured within a ± 0.2 per cent variance.



COUNTER CONTROLS developed by the Walkirt Co., Inglewood, Calif., are bringing noteworthy savings to fruit and nut handling industries. Equipment supplants manual labor associated with packing operations, previously a necessity to meet government regulations concerning underpacking. In past, packers sacrificed accuracy of counting by deliberate overpacking to achieve speed in the operation. New setup controls feed of fruit into box by desired count and controls conveyor which moves boxes to and from feeding unit.

First Manufacturing Automation Conference To Stress Today's Practical Approach

PROGRAM arrangements have been completed for the First Conference on Manufacturing Automation to be cosponsored by Purdue University and AUTOMATION Magazine. The three-day conference will convene on the campus of Purdue University October 22, 23 and 24 under the sponsorship of the School of Mechanical Engineering and School of Industrial Engineering.

In recognition of the current need of key engineering and manufacturing executives. the basic aim of the conference is to provide a broad insight into the complex area of manufacturing automation. In accomplishing this aim, the meeting will begin with a comprehensive general orientation of automation as it is found in manufacturing industries today, and then proceed to a more detailed consideration of the fundamental aspects pertinent to these industries. Having reviewed and established the practical basis for automation, the conference will cover in detail some of the primary approaches to manufacturing automation and will close with three sessions designed to answer the most practical question, "How to proceed with automating a desired operation?"

Speakers for all sessions of the three-day conference have been drawn from a wide variety of industries. Their combined background of experience in various phases of manufacturing automa-

tion will make available to attendees not only the breadth of view necessary to a complete understanding of the field, but also specific and practical answers to a variety of problems common to other industries.

Details of the program, speakers and subjects of the various sessions follow:

Monday, Oct. 22

Registration—9:00 a.m.
Program Orientation—9:45 a.m.
General theme of Monday's sessions —*Automation and Its Use Today.*

1. *Developing Small Scale Automation*—10:15 a.m.; presented by **F. F. White,** Vice President, Engineering, Automation Development Corp.
2. *Developing Large Scale Automation*—11:15 a.m.; presented by **P. H. Alspach,** Manager, Equipment Development Laboratories, General Electric Co.

Buffet Lunch—12:30 p.m.

3. *Automation for Water Heaters* —2:00 p.m.; presented by **H. M. Gage,** Administrative Assistant to General Manager-Marketing, Plumbing & Heating Div., Rheem Mfg. Co.
4. *Automation for Jet Engines;* presented by **R. L. Grunewald,** Manager, EOD Components & Overhaul, General Electric Co.
5. *Automation for Valves;* presented by **M. D. Braid,** Factory Engineer, Valve Div., Thompson Products Inc.
6. *Automation for Pens;* presented by **O. Jendresen,** Senior Engineer, The Parker Pen Co.

Motion Picture and smoker—8:00 p.m.

Tuesday, Oct. 23

General theme of Tuesday's sessions —*Fundamental Aspects of Automation.*

1. *Economic Study*—9:00 a.m.; presented by **C. E. Evanson,** President, T.A.B. Engineers Inc.
2. *The Practical Approach*—10:00 a.m.; presented by **D. M. Swartz,** Secretary, Automation Industries Inc.
3. *Automation In the Plant*—11:00 am.; presented by **G. W. Jernstedt,** Director, Manufacturing Engineering Laboratory, Westinghouse Electric Corp.

Buffet Lunch—12:30 p.m.

4. *The Manufacturing Cycle*—2:00 p.m.; presented by **J. C. Keebler,** Associate Editor, AUTOMATION.
5. *Production Control for Flexibility*—3:00 p.m.; presented by **W. M. Willitts,** Engineer, Merimac Valley Works, Western Electric Co.
6. *The Product*—4:00 p.m.; presented by **W. M. Schweder,** Manager, Low Integral Horsepower Motor Product, Engineering Sub-Section, Medium Induction Motor Dept., General Electric Co.

Banquet—6:30 p.m. Principal speaker, **H. Bentley,** Manager, Production Planning, Engine Div., Chrysler Corp. Subject, *The Automated Plant.*

Wednesday, Oct. 24

General theme of morning sessions —*The Processing Equipment.*

1. *Using Standard Equipment*—8:30 a.m.; presented by **D. A. Cargill,** President, Cargill Detroit Corp.
2. *"Building Block" Equipment*—9:30 a.m.; presented by **P. H. Richardson,** Engineering Vice President, The Hartford Special Machinery Co.
3. *Transfer Machines*—10:30 a.m.; presented by **R. E. Cross,** Executive Vice President, The Cross Co.
4. *Special Purpose Lines*—11:30 a.m.; presented by **Robert Sattler,** Vice President, LaSalle Tool Co.

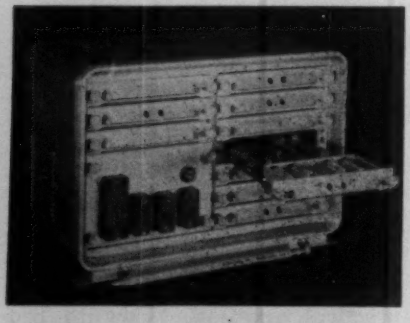
Buffet Lunch—12:30 p.m.
General theme of closing sessions—*Methods Used in Automating a Desired Operation.*

5. *Do It Yourself?*—2:00 p.m.; presented by **C. F. Carlzen,** Manager, Automation Engineering Sylvania Electric Products Inc.
6. *Use the Specialist?*—3:00 p.m.; presented by **R. B. Billingham,** Vice President & General Manager, W. F. & John Barnes Co.
7. *Use the Consultant?*—4:00 p.m.; presented by **I. Ingraham** and **J. Y. Rust,** Professional Engineers, Giffels & Vallet Inc.

Time will be alloted in all sessions to discussion from the floor. Specific questions pertinent to the conference may be sent in advance to the Editor, AUTOMATION; Prof. E. S. Ault, Purdue University, Lafayette, Ind. or included with advance registration forms.

Fee for the conference is $75 which will include banquet and buffet luncheon tickets and a copy of the transactions which will be published upon completion of the conference.

Additional information on the conference lodging and transportation details may be obtained by mail or phone from K. E. Glancy, Div. of Adult Education, Purdue University, Lafayette, Ind.



DIGITAL encoder developed by Radiation Inc., Melbourne, Fla., is designed to accept 0-10 v input levels and generate 24,000 eight-bit binary code groups per second, defining the input at an overall accuracy of one part in 256. The coder's electronic circuitry, including solid state components, is mounted on etched circuit plug-in cards for increased operational reliability and ease of maintenance.

Stepless Crane Control

STEPLESS control for overhead electric traveling cranes has been developed by Harnischfeger Corp. based on an electronic control circuit. The new control scheme has greatly reduced the number of mechanical contactors, and thus eliminated the major source of maintenance required in crane electrical equipment.

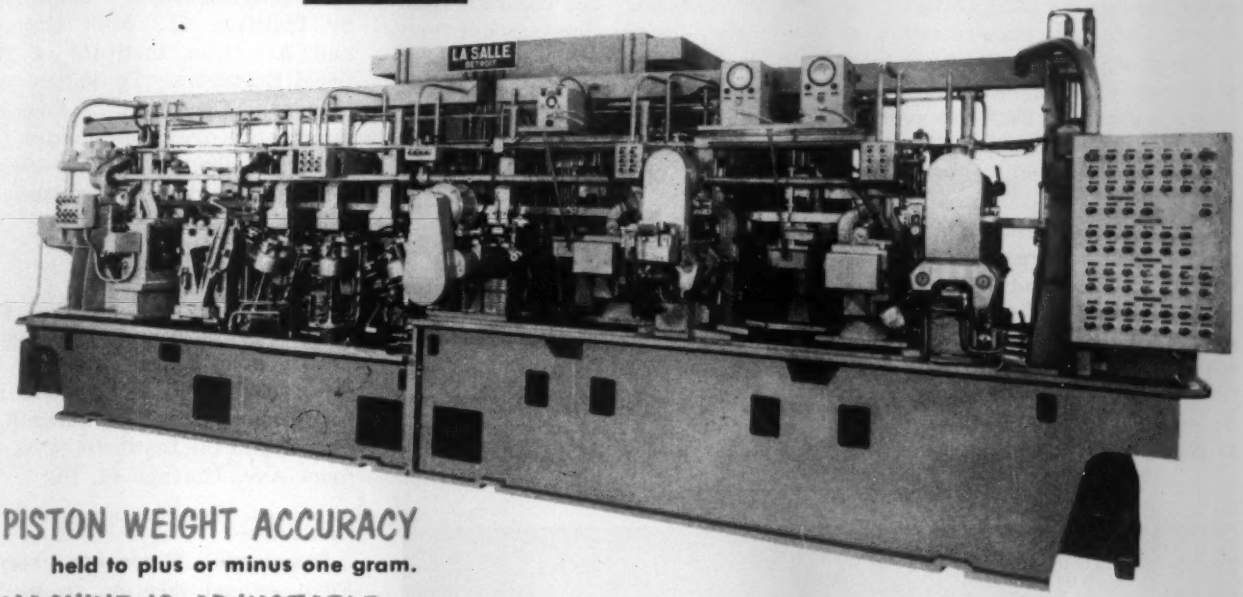
Applied in conjunction with the standard P&H Magnetorque, the stepless control provides an infinite number of speed variations, on all motions, thereby providing the high degree of control and precision spotting in both lowering and hoisting directions under all conditions from no load to full load. Also, hoisting and lowering speed are stabilized to a high degree, resulting in an almost flat speed-torque curve.

Automation Influences Future of Screw Machine Products

TEN-YEAR forecast of conditions concerning screw machine products has been made by the National Screw Machine Products Association. The Association predicts that there will be fewer screw machine products producers, but that existing producers in 1965 will be

La Salle AUTOMATED PISTON LINE

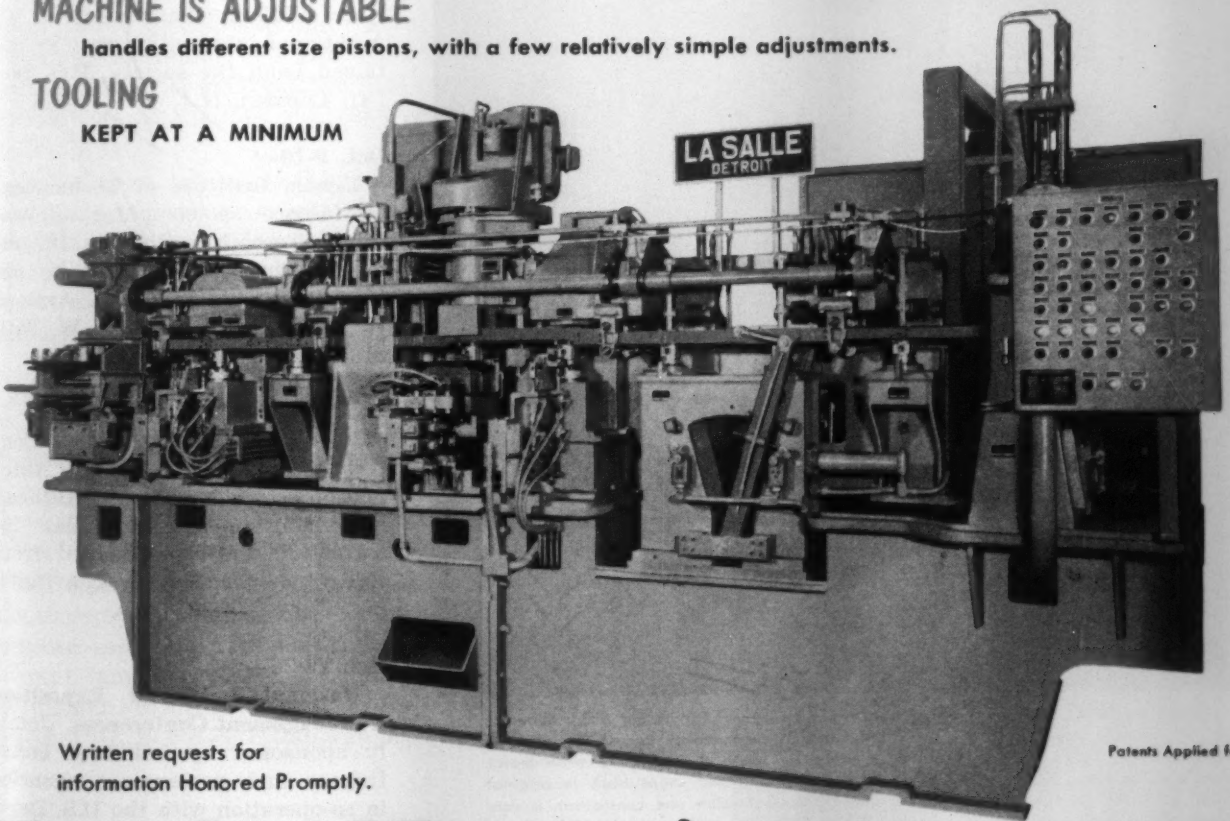
PRODUCES 400 PISTONS PER HOUR



PISTON WEIGHT ACCURACY
held to plus or minus one gram.

MACHINE IS ADJUSTABLE
handles different size pistons, with a few relatively simple adjustments.

TOOLING
KEPT AT A MINIMUM



Written requests for information Honored Promptly.

Patents Applied for.

La Salle tool, inc.

ENGINEERING & BUILDING
SPECIAL MACHINERY

3840 EAST OUTER DRIVE • DETROIT 34, MICHIGAN

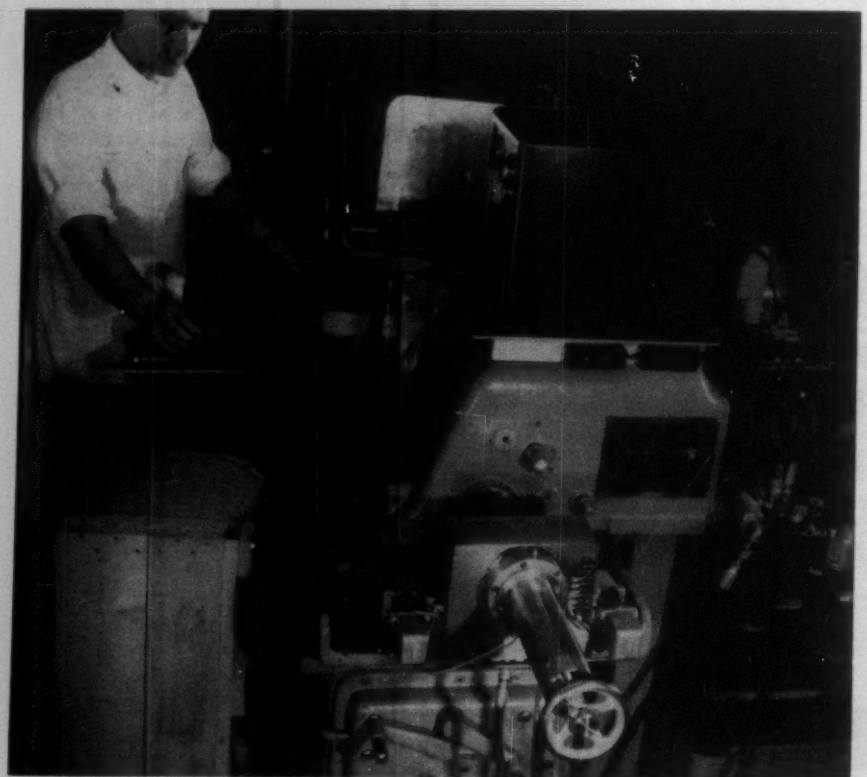
Circle 559 on Inquiry Card

larger in size, partly because of the current death rate among the small companies, and partly because screw machines are becoming more costly and demand more skilled personnel as operators. The report adds that modernization of existing equipment is the important goal for the industry and it may be expected that the average age for screw machines by 1965 will be less than half of what it is today. With more automation and better material handling, it is expected that electronic inspection will take over and become more prevalent. This is particularly important because inspection has always been an area of high cost for machine screw product firms where rejects have averaged 2 to 3 per cent of total sales.

Corrosion Problems Lead To Boiler Instrumentation Study

PROTOTYPE instrumentation for tests to determine the feasibility of automatic boiler water monitoring systems will be developed by Beckman Instruments Inc. under a Navy contract. The contract calls for the design, development and application engineering of two prototype instruments for use on a round-the-clock basis and an automatic alarm system to warn operators of off-standard conditions which could prove destructive to high pressure steam generating systems.

One prototype instrument is for continuously monitoring the pH of boiler water, and the other for monitoring the chloride ion content of the water. These factors are important in that corrosion can start in high pressure boilers within a matter of a few hours if the necessary precautions are not taken.



LINEAR ACTUATOR developed by Airborne Instruments Laboratory Inc., Mineola, N. Y., literally steps along in microinch increments. Unit makes use of the physical phenomenon, called the magnetostrictive effect, in which the armature of a motor shrinks under the influence of an electromagnetic field and snaps back to original size when the magnetic field is de-energized. This expansion and contraction is converted into forward or backward motion, capable of reversing on demand without backlash. The unit is shown in use on a centerless grinder producing precisely finished hydraulic components. The device lends itself well to the automation trend in the machine tool field in that it will, through a simple converter, respond directly to gage signals. In this manner, machines may be made continuously responsive to tool variations as well as material hardness variations and the many other variables that enter into precise machine finishing.

MEETINGS AND EVENTS

Sept. 24-25—

Fifth Annual Industral Electronics Symposium. Cosponsored by Institute of Radio Engineers and American Institute of Electrical Engineers. To be held Hotel Manger, Cleveland. Additional information may be obtained from Robert Rodgers, *Machine Design*, Penton Building. Cleveland 13, Ohio.

Oct. 1-3—

Twelfth Annual National Electronics Conference and Exhibition. To be held Hotel Sherman, Chicago. Additional information may be obtained from G. J. Argall, De Vry Technical Institute, 4141 Belmont Ave., Chicago 41, Ill.

Oct. 3-5—

Standards Engineers Society. Fifth annual meeting to be held Hotel Willard, Washington, D. C. Additional information may be obtained from the society, P.O. Box 281, Camden, N.J.

Oct. 9-10—

Illinois Institute of Technology. Conference on computer applications. To be held Chicago, Ill. Additional information may be obtained from J. J. Kowal, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 22-24—

Purdue University. First Conference on Manufacturing Automation cosponsored by *Automation* Magazine. Additional information may be obtained from Editor, *Automation*, Penton Building, Cleveland 13, Ohio.

Oct. 22-26—

National Industrial Exposition & Management Conferences. Jointly sponsored by industry, labor, finance and government agencies in co-operation with the U.S. Dept. of Commerce and Defense to be held Detroit. Additional information may be obtained from A. F. Denham, 927 Book Bldg., Detroit 26, Mich.

CYPAK AT WORK...

simplifies automatic control of transfer machines

When you're considering the cost of transfer-type machining operations, look at the new areas of return from the simplicity of CYPAK* control systems. Transfer machine installations of CYPAK are proving two important facts.

First, CYPAK has made the first major change in simplifying industrial control reliability. The control elements have no moving parts to wear, corrode or jam. Conservatively rated, CYPAK life is many times longer than conventional relay systems. You can measure the savings in more continuous production . . . control replacement costs eliminated.

And second, CYPAK design greatly improves the physical simplicity . . . ease of inspection, addition, or change of transfer machine control. Each CYPAK element is encased in a protective plastic block. These are plugged-in—locked-in to a common power channel forming a compact, simply wired system.

We'd like to give you further proof of CYPAK contributions to complex machine control. Your Westinghouse sales engineer has full reports on many different applications. Call him today or write Westinghouse Electric Corporation, Dept. B, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa. *Trade-Mark

J-21964

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

AUTOMATION NEWS FEATURE

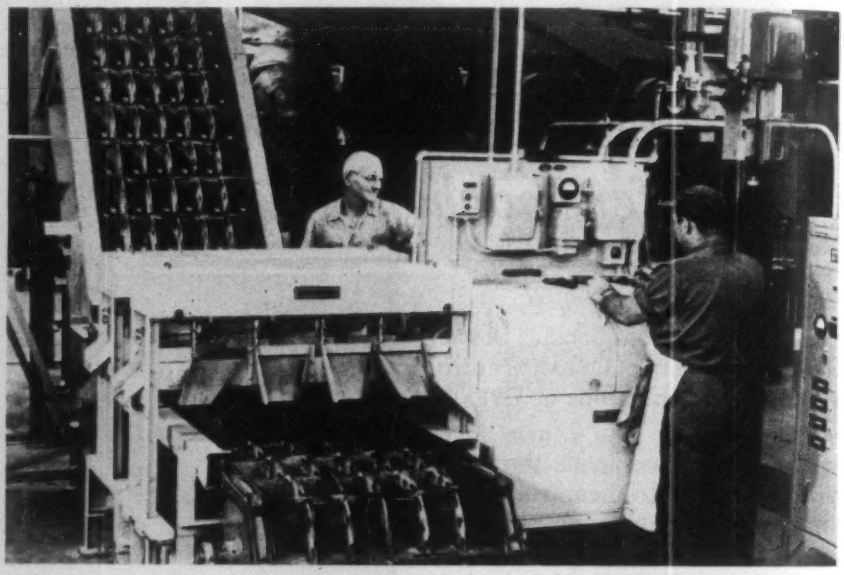
Industry Views . . . .

Packaging and Instrument Controls

Expositions Feature Latest Equipment

EVIDENCE of the vitality of American industry is nowhere more apparent than in the many large trade shows which have occurred during recent times. To the interested observer, the various shows afford an unequalled opportunity to measure both the extent and penetration of automation into the various vertical fields comprising our industrial complex. Two major shows are convening in September—Packaging Machinery and Materials Exposition of 1956 to be held in Cleveland Sept. 11-14, and the Eleventh Annual International Instrument-Automation Conference to be held in New York City Sept. 17-21. So far as automation in these two fields is concerned, the role of instrument control is so apparent that some proponents insist that only it *is* automation. And no one who has witnessed some of the modern high-speed packaging lines with automatic filling, checkweighing, wrapping, and control equipment can help but be impressed with the degree of automation possible in the overall packaging operation.

In keeping with AUTOMATION's policy of highlighting important areas with the occurrence of major trade shows, the following pages are devoted to observations by recognized experts in both the packaging and instrumentation control fields. The general theme of packaging is examined from the standpoint of an increasingly important problem — integration of the packaging operation into the production line. In recognition of the immense task in keeping up with developments in instrumentation control, the several control experts have covered recent advances which are significant not only because of the actual capabilities of the controls covered, but also because of the future overall advancements which are foretold.



AUTOMATIC checkweighing equipment developed by Exact Weight Scale Co. for packaging industry is adaptable to wide range of industrial uses such as this operation in which connecting rods are weighed, sorted and classified into eight weight classifications.

PACKAGING

Checkweighing Equipment Serves Variety of Needs In Industry

By J. E. KONKLE
Advertising Manager
The Exact Weight Scale Co.

ONE OF THE MOST important limiting factors in some packaging lines is the weighing operation—and the development of suitable weighing equipment to meet the production and accuracy requirements of modern high-speed lines has been the basis for practical automation in various industries. The Exact Weight Scale Co. has been a leading contributor in developing automatic weighing equipment which has kept pace with demands made by industry.

Within industry, an amazing amount of progress has taken place within the last 30 to 40 years. From the "cracker barrel era", manual weighing operations progressed to gradual acceptance of the over-and-under type production scales used in various types of food and chemical product lines in packaging, bagging, and sacking operations. As production speeds increased, demand for continued accuracy with increased speed of weighing led to the development of semiautomatic machines. Widely used today, the equipment consists of combinations of various precision manual scales with vibratory type feeders, and automatic operating valves. With further increases in production speeds, the completely automatic net weighing machine was developed. Essentially, the machine consists of a precision one to one ratio type scale with vibratory feeders and feeder machine controls built around a photoelectric cell or mercury magnetic sensing devices.

Perhaps the development which most clearly illustrates the value of weighing equipment to the modern integrated packaging line is Exact Weight Scale Co.'s Selectrol, an automatic checkweighing machine which also has many industrial uses outside of the packaging field.

All packages sold on a weight basis are not necessarily weighed at filling. Manufacturers, to obtain production speed and resultant quantity output, have found that it is economical in some cases to set filling equipment to deliberately place an over-fill in all packages. Speed of packaging is obtained, but with large quantity runs the slight over-fill be-

Adjustable Speed

Is Your Drive Problem in this List?

AIRCRAFT INDUSTRY
- ☐ Wind Tunnels
- ☐ Dynamometers
- ☐ Accessory Testing

AUTOMOTIVE INDUSTRY
- ☐ Conveyors
- ☐ Machine Tools
- ☐ Presses
- ☐ Dynamometers

CALCINED PRODUCTS
- ☐ Kilns
- ☐ Fans
- ☐ Feeders
- ☐ Conveyors

CHEMICALS
- ☐ Pumps
- ☐ Conveyors
- ☐ Process Machinery
- ☐ Winders

FOOD PROCESSING
- ☐ Mixers
- ☐ Dryers
- ☐ Conveyors
- ☐ Mills

GRAPHIC ARTS
- ☐ Main Presses
- ☐ Press Auxiliaries
- ☐ Winders
- ☐ Slitters

MATERIALS HANDLING
- ☐ Conveyors
- ☐ Cranes
- ☐ Shovels
- ☐ Lift Trucks

MINING
- ☐ Conveyors
- ☐ Hoists
- ☐ Mills

METAL WORKING
- ☐ Rolling Mills
- ☐ Presses
- ☐ Winders
- ☐ Slitters
- ☐ Loop Cars

PULP AND PAPER
- ☐ Paper Machines
- ☐ Auxiliary Helpers
- ☐ Converting Machines
- ☐ Finishing Machines
- ☐ Pulp Processing Machines

RUBBER AND PLASTICS
- ☐ Extruders
- ☐ Plasticizers
- ☐ Calenders
- ☐ Winders

TESTING
- ☐ Engines
- ☐ Pumps
- ☐ Motors
- ☐ Auxiliaries
- ☐ Wind Tunnels

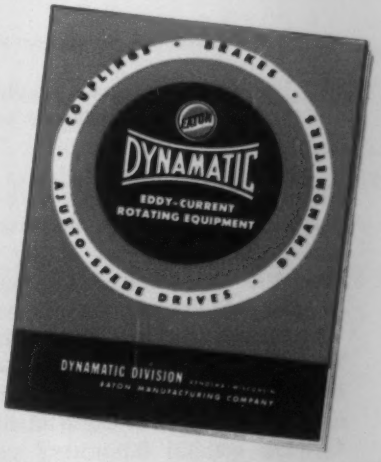
TEXTILES
- ☐ Winders
- ☐ Slashers
- ☐ Dryers
- ☐ Batchers

UTILITIES
- ☐ Fans
- ☐ Boiler Feed Pumps
- ☐ Feeders

DYNAMATIC®

Eddy-Current Equipment Can Be the Solution

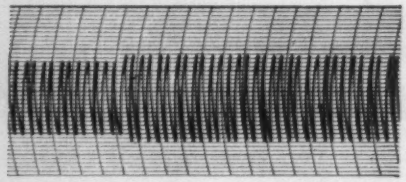
Using standard AC lines as a power source, Dynamatic torque transmitting equipment satisfies most stepless adjustable speed requirements. Dynamatic Ajusto-Spede® and Dynaspede® Drives, Couplings, Brakes, and Dynamometers with electronic or magnetic amplifier control provide the advantages of rapid response, wide speed range, quiet operation, low power losses, low maintenance cost, and remote control.



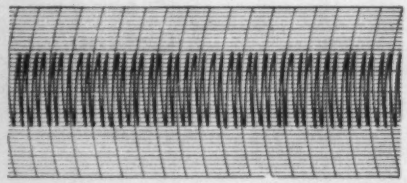
Send for your free copy of the Dynamatic Bulletin GB-2, which illustrates and describes eddy-current adjustable speed rotating equipment.

EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Regulation in *less than 1/50th cycle . . .*



Output of typical electromechanical regulator.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Actual oscillograms of 60 cps voltage.

Actual 60 c.p.s. waveform

PLUS Pure Sine Wave Power

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

Faster recovery time (less than 1/50th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion — these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

Circle 562 on Inquiry Card

comes anything but slight. The conflict between speed and accuracy needed to be reconciled. Essentially, the problem becomes one of checking weights of packages in some form in order to control the filling operation and reduce the give-away factor to an absolute minimum.

With high speed filling machines in use today, human control is impossible and half-measures, such as spot checking, are economically impractical. The Selectrol fills a natural need for an checkweighing machine which can inspect all packages.

In operation, previously filled packages are passed at a rate up to 100 per minute over a sensitive balance connected by means of electronic circuitry to over-under reject gates at the outlet of the machine. Packages whose weight falls within an allowable range proceed by conveyor to the closing operation; over and underfilled packages are separated and can be trimmed manually at some convenient time.

Complete integration of the checkweighing operation into the production line occurs with the use of companion control equipment with the Selectrol. The control equipment consists of average and range computing elements, control indicator, automatic chart plotter, and means for adjusting the processing machine. Based on signals received from the checkweighing equipment which has classified each package, the average computer element calculates the average weight of ten consecutive packages and, simultaneously, the range computing element calculates the difference between the maximum and minimum weight in the group of ten packages. This information can be fed into the recorder for detailed study and guidance, and can form the basis for correction to the processing equipment when compared to statistically predetermined limits established for the particular operation.

The value of automatic equipment capable of checkweighing industrial items rapidly and accurately is not limited to packaging lines. For instance, in the automotive industry finished conecting rods must be classified by weight. The Plymouth engine plant has been furnished an installation which weighs, sorts and classifies connecting rods into eight weight classifications. The entire operation is automatic; it is fed by conveyor and the parts, after classification, are removed by conveyor.

So far as packaging and weighing are concerned, the trends point to closer integration since quantity requirements lead to the need for speed in processing and speed soon outpaces human capabilities of control.

AUTOMATION
READER SERVICE

Use an Inquiry Card

FOR FURTHER INFORMATION ON ANYTHING DESCRIBED OR ADVERTISED IN THIS ISSUE

NEW EQUIPMENT
starts on page 83

•

NEW COMPONENTS
starts on page 104

•

CATALOGS and LITERATURE
starts on page 124

•

ADVERTISED PRODUCTS OR SERVICES

•

EXTRA COPIES OF ARTICLES
Get a personal copy of any article

Circle item number for further information on anything described or advertised in this issue

401	431	461	491	521	551	581	611	641
402	432	462	492	522	552	582	612	642
403	433	463	493	523	553	583	613	643
404	434	464	494	524	554	584	614	644
405	435	465	495	525	555	585	615	645
406	436	466	496	526	556	586	616	646
407	437	467	497	527	557	587	617	647
408	438	468	498	528	558	588	618	648
409	439	469	499	529	559	589	619	649
410	440	470	500	530	560	590	620	650
411	441	471	501	531	561	591	621	651
412	442	472	502	532	562	592	622	652
413	443	473	503	533	563	593	623	653
414	444	474	504	534	564	594	624	654
415	445	475	505	535	565	595	625	655
416	446	476	506	536	566	596	626	656
417	447	477	507	537	567	597	627	657
418	448	478	508	538	568	598	628	658
419	449	479	509	539	569	599	629	659
420	450	480	510	540	570	600	630	660
421	451	481	511	541	571	601	631	661
422	452	482	512	542	572	602	632	662
423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
430	460	490	520	550	580	610	640	670

AUTOMATION — SEPTEMBER 1956

SEND COPIES OF FOLLOWING ARTICLES IN THIS ISSUE

Page No. — Title of Article

....

....

....

Must Be Filled Out Completely—Type or Print

NAME

TITLE

COMPANY

PRODUCT MANUFACTURED

ADDRESS

CITY ZONE

STATE

Do not use this card after November 15, 1956

Circle item number for further information on anything described or advertised in this issue

401	431	461	491	521	551	581	611	641
402	432	462	492	522	552	582	612	642
403	433	463	493	523	553	583	613	643
404	434	464	494	524	554	584	614	644
405	435	465	495	525	555	585	615	645
406	436	466	496	526	556	586	616	646
407	437	467	497	527	557	587	617	647
408	438	468	498	528	558	588	618	648
409	439	469	499	529	559	589	619	649
410	440	470	500	530	560	590	620	650
411	441	471	501	531	561	591	621	651
412	442	472	502	532	562	592	622	652
413	443	473	503	533	563	593	623	653
414	444	474	504	534	564	594	624	654
415	445	475	505	535	565	595	625	655
416	446	476	506	536	566	596	626	656
417	447	477	507	537	567	597	627	657
418	448	478	508	538	568	598	628	658
419	449	479	509	539	569	599	629	659
420	450	480	510	540	570	600	630	660
421	451	481	511	541	571	601	631	661
422	452	482	512	542	572	602	632	662
423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
430	460	490	520	550	580	610	640	670

AUTOMATION — SEPTEMBER 1956

SEND COPIES OF FOLLOWING ARTICLES IN THIS ISSUE

Page No. — Title of Article

....

....

....

Must Be Filled Out Completely—Type or Print

NAME

TITLE

COMPANY

PRODUCT MANUFACTURED

ADDRESS

CITY ZONE

STATE

Do not use this card after November 15, 1956

Information Service

For your convenience, advertisements and items of information on new equipment, components and manufacturers literature now can be quickly identified by an *Item Number* printed just below each unit.

For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

So that you won't have to clip this issue, we will gladly send you a personal copy of any article. Just fill in the page number and title of the article you desire.

FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

—4c POSTAGE WILL BE PAID BY—

AUTOMATION
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

Use a Postage-Paid Inquiry Card!

FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

—4c POSTAGE WILL BE PAID BY—

AUTOMATION
Penton Building
Cleveland 13, Ohio

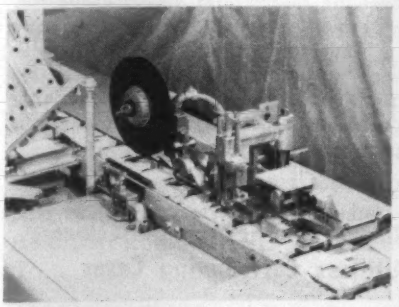
Reader's Service Dept.

Keep Up-to-Date!

Pressure Sensitive Tape Adaptable to Industrial Needs

By ORVILLE JOHNSON
Supervisor, Field Service
Tape Customer Engineering Dept.
Minnesota Mining & Mfg. Co.

PRESSURE SENSITIVE tape today automatically closes boxes, staples objects to display cards, labels parts, combines units for special promotions and performs a variety of services for a growing number of industries. Eight years ago only one of these functions, carton and box sealing, could be accomplished with tape since only this job could be done manually at an economical rate. During those eight years, however, design ingenuity, mechanical developments and the adaptability of pressure sensitive tape to



SPECIAL machine designed by Minnesota Mining & Mfg. Co. automatically staples items to card with pressure sensitive tape. View indicates endless carriers which are automatically loaded with die-cut cards and objects to be stapled.

assembly line speeds have whetted the industrial appetite for new procedures to apply tape automatically.

Generally these new procedures—or trends—can be accomplished by one of five basic applicator principles:

1 Carton closing—using either an automatic box sealer or an air operated carton taper. Both cut and apply short strips of tape to seal a container.

2. Combining—using a combination package bundler which applies tape around two or more units.

3. Stapling—using a tape stapler which attaches small obpects to display cards with tape applied through die cut holes in the cards.

4. Labeling—employing a flat surface applicator which cuts and rolls flat short strips of tape.

5. Sealing or covering openings—using an automatic lid taping machine which cuts and pats small clips of tape over holes in flat surfaces.

Requests for automatic equipment usually are made from one of two considerations. The manufacturer wants: (1) *Reduced costs.* Automatic equipment eliminates high labor costs, provides uniform applications and an

NEW HAGEN
hand set
time delay relay

Foolproof on Repeat Settings

No danger of over-timing when you repeat a process several times — each with the same timing. On the first run, operator simply presses the stop release button and sets the adjustable stop (both shown in blue) at the desired time . . . then turns the pointer as far to the right as it will go . . . it can't go beyond the stop. Thus the setting is always correct — on the first and all subsequent runs.

A synchronous motor returns the cam shaft to "O" position, tripping switches in accordance with time settings. The process is stopped automatically.

A wide selection of snap-action switches is available . . . as well as cam combinations. The Hagen Hand Set Time Delay Relay Model 73 is the answer to controlling solenoid valves in an industrial process, starting a group of motors in sequence, for pump controls, and many other uses.

Send for Bulletin 580

MAIL COUPON TODAY!

HAGEN
MANUFACTURING COMPANY INC.
Moline, Illinois
Subsidiary of Eagle Signal Corporation

HAGEN MANUFACTURING COMPANY, INC.
Dept. A-956, Moline, Illinois

Please send Bulletin 580 on the new Hagen Hand Set Time Delay Relay.

NAME AND TITLE
COMPANY
ADDRESS
CITY ZONE STATE

Circle 563 on Inquiry Card

uninterrupted flow of production. (2) *Increased marketability.* When new promotions are being introduced, the manufacturer with the best technique and the best appearing product will have the best selling chance.

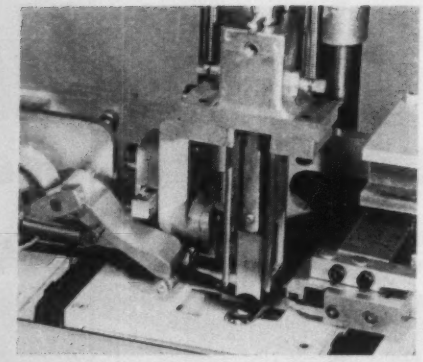
Frequently, a manufacturer wants machinery to band two or more like or unlike products together for premium offers, or combination deals. He might desire either to boost sales by offering an extra unit at a lower than usual price, or to introduce a new product by taping it to an established one at a reduced "introductory" price. While tape adds to unit cost in this case, the increased sales appeal of the taped product more than offsets that cost. Sales messages also can be printed on the tape.

One manufacturer using a combination package bundler has found it more than satisfactory to combine his product and a give-away item. "I have to use pressure sensitive tape," he said. "It's the only way I can sell my product."

Normally, inquiries for mechanical aids begin with a salesman contact in the field. A manufacturer may be sold on the idea of employing tape in his production scheme, but he wants it applied automatically. Studies are made from the report prepared by the contact salesman, and schematic drawings of proposed machinery are roughed out along with a description of how the machinery will operate. With this recommendation, the salesman contacts the manufacturer again and, if the report is accepted, asks permission to have a field engineer come in for a problem survey. Once an automatic machine is decided upon, field engineers will assist in its installation and instruction of personnel during the initial operating phase.

Several kitchen cleanser manufacturers presented another special problem. The companies had decided to drop an old lid design and substitute prepunched holes, thus freeing the housewife of a bothersome task. Accomplishing this required a siftproof covering to protect the contents between the time the container would leave the assembly line and it would be opened by the housewife. Pressure sensitive tape was suggested as the material to close the holes, but to apply it by hand would be a costly process unable to satisfy intake requirements of the production line.

Customer engineering was handed the problem, and the answer was found in the idea and plans for a lid taper. It applies better than 300 short strips of tape per minute to that many can lids. The machine is not fully integrated into a production line as it requires one operator to load stacks of untaped lids and unload stacks of taped lids. Taped lids are magazine fed into the production line.



DETAILS of tape stapling assembly. Strip of tape is pulled under stapling arms, cut from roll and both free ends passed through holes in card. Buffing fingers press the tape to back of the card.

Development of a box taper operated by a power source other than electrical was another unusual problem solved by customer engineering service. The manufacturer had a critical packaging operation in which he wanted to remove an operator from a hazardous location and eliminate even the remotest danger of sparks. To meet these requirements, a fully automatic, air operated machine was designed, constructed and integrated into the production line. It is unique in that it accepts cartons of different sizes in any sequence, automatically centers them, clamps the lid securely and applies a C-shaped tape strip to the top and bottom and along both sides of the carton before sending it down a conveyor line to the shipping room.

Numerous requests for a machine to automatically label parts and whole products are easily filled with a flat surface applicator. Today these machines, which apply strips of tape—either transparent, colored or printed—at rates up to 80 applications per minute, are used for labeling such diverse items as auto horns, polyethylene tubing, cigar boxes and window glass.

Frequently requests are received which cannot be efficiently served by an existing machine or adaptation. The equipment is then designed from scratch. The tape stapler began this way after a manufacturer inquired about a method to attach merchandise to a display card. He wanted the units attached firmly to discourage pilfering, yet in a manner to heighten sales appeal. The tape stapler, which automatically staples the merchandise to cards with a short strip of tape and ejects the complete units, was designed and installed in his plant.

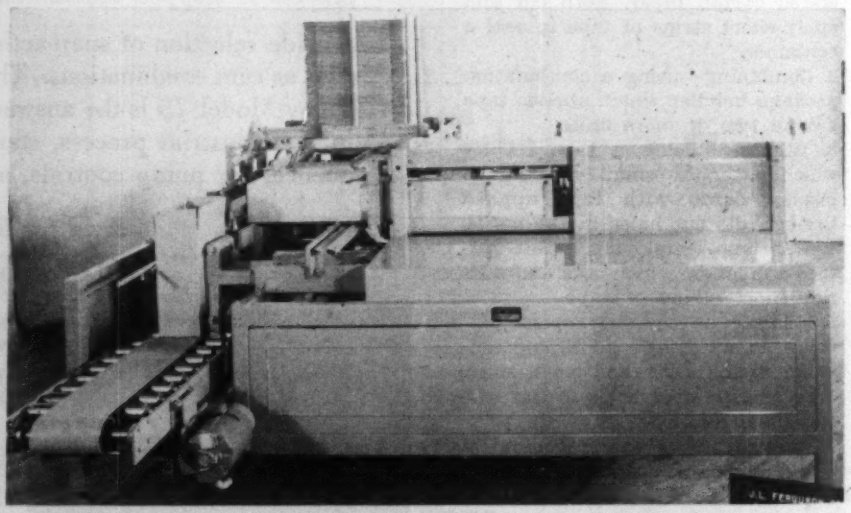
In the future, as production lines become faster and more automatic, tape will keep abreast of the times by development of better and faster tape applying equipment. Research now envisages the use of tape in processes requiring 1000 applications per minute.

Improved Packaging Machinery Utilizes Cost Saving Cases

By DONALD O. FERGUSON
Vice President
J. L. Ferguson Co.

RECENT DEVELOPMENTS in automatic packaging machinery at the J. L. Ferguson Co. and improved methods of loading and sealing end-opening shipping cases have resulted in increased acceptance of Packomatic end-loading equipment in plants across the nation.

The reason for industry's trend toward packing with end-loading cases is quite obvious—field-tested,



END LOADING CASES, fed into machine from magazine, are formed, positioned and loaded automatically with machine developed by J. L. Ferguson Co. In illustrated machine, frozen food packages are loaded at rate of 390 per minute.

Louden Selectomatic-Automatic Dispatch

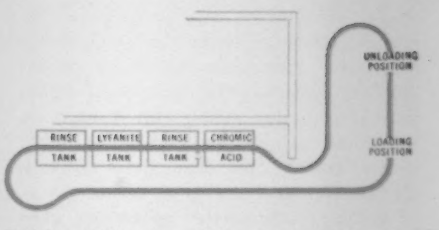
Louden's contribution to* AUTOMATION *here saves $25,000 a year

Louden Selectomatic-Automatic Dispatch is an application of automatic, unattended operation to materials handling and as such is serving many large industrials the country over. It is further indication of Louden's ability to turn the fundamental advantages of overhead handling to greatest account. The typical installation shown here is in the Johnson Motors, Waukegan, Ill., outboard manufacturer plant. Its function is to carry aluminum parts through a Lyfaniting (anti-corrosion) process. The moment its basket is loaded by one man and the button pushed, it carries on by itself, dipping basket contents into a series of tanks for stipulated periods of time, and then running its load to a second man who unloads it. The Selectomatic-Automatic Dispatch System replaces a hand-operated monorail system and accomplishes in *one* shift what it used to take 3 shifts to do. On an initial investment of only $16,000, this user is saving in excess of $25,000 a year!

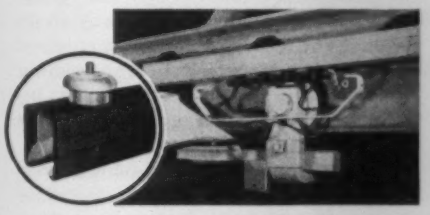
The availability of such equipment is a reciprocating testimonial to the breadth and penetration of Louden engineering. Truly Louden turns to greatest account the advantages of overhead handling—providing the finishing touch that makes the difference between "pretty good" and outstanding. Call in a Louden man for help on *your* handling problems.

THE LOUDEN MACHINERY COMPANY
6809 Broadway, Fairfield, Iowa

A Subsidiary of Mechanical Handling Systems, Inc.



Louden Selectomatic-Automatic Dispatch embodies the principle of automatic control as applied to materials handling operations. In some installations, it even exemplifies true AUTOMATION. By combining monorail track, the appropriate current-carrying and current-controlling devices, motorized conveyors, and the appropriate type of carriers, the completely automatic and unattended handling, carriage and processing of many materials and parts are achieved. Impressive economies, production increases and quality improvement are the result. Write for new, illustrated booklet "Automatic Materials Handling" sent without obligation.



New! Louden Shokpruf Electrification ... for all monorail and crane installations. Hazards of open conductor bars now completely overcome by this exclusive Louden engineering development. Write for full details of this safe conductor system.

Louden
MONORAIL & CRANES
SINCE 1867...THE FIRST NAME IN MATERIALS HANDLING

fully automatic machines have reduced packing costs for a number of major companies by many thousands of dollars. For, with end-loading equipment, in nearly all instances, products can be packed in shipping cases which cost less than conventional top opening type cases.

With Packomatic machines, the range and application as to items handled is so varied as to include almost any type container—round, square (frozen food cartons), or rectangular—paper or metal.

Since shipping-case costs are based to some extent on the board required, and since end-opening cases have smaller closing flaps, the board reduction—and the subsequent price reduction — is substantial. Figures in our files show that the costs of end-opening cases are anywhere from $3 to $20 per thousand cheaper than the conventional top opening type cases, and there may be instances where even greater savings would be effected.

In addition to board savings, end-opening cases offer other desirable features. Because it has a flat, smooth side surface, the end-opening case may be palletized easily on its flat side. Exhaustive tests conducted in our own plant and by box fabricators speak well for the stability of the end-opening case. Tumbling tests, stacking tests, bursting tests and shipping tests have proved that end-opening cases are stronger than top opening style cases.

Within the past few months, a new Packomatic machine—the first in the industry—has been operated successfully by one of the nation's leading frozen food processors, Morton Packing Co. The new packaging machine loads frozen meat pot pies in a 2 x 3 x 4 pattern, 24 pie cartons per case at the rate of 390 cartons per minute. The company has realized a 13¼ per cent saving in paperboard alone by using the end opening style shipping case for this product. This machine used by Morton is a fully automatic "Feeder, Former, Positioner and Loader" accommodating end-opening style corrugated shipping containers.

The machine feeds out a corrugated shipping container (in flat form) from its magazine; the end-opening case is then automatically formed, positioned and loaded. The entire operation is accomplished automatically with but a single part-time operator required to keep the magazine supplied with flat shipping containers. The machine discharges the loaded shipping container to a top and bottom case sealer. Result: A case that is formed, positioned, loaded and sealed, fully automatically, ready for shipment.

A very important advantage of end-opening packing techniques is the fact that loading or packing equipment by Packomatic operates in a manner that eliminates rough handling of cans and packages, reducing the danger of damage to containers.

For example, instead of rolling or sliding cans on their lithographed or labeled surfaces, cans are conveyed to the loader and handled through it on their bottoms—the strongest part of the can. Cans ride head to head rather than head to body. There is no banging which might cause dents or "leakers." The conveying, collecting, assembling and loading operations are smooth and gentle, yet fast and efficient. Cartoned products are also handled gently, yet speedily.

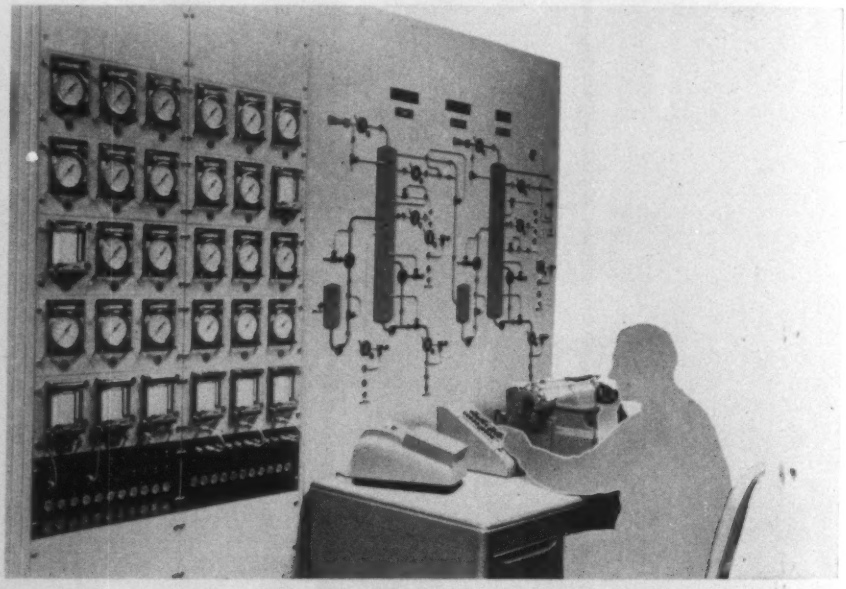
INSTRUMENT CONTROLS

Complete Information Center Key To Better Control

By Dr. L. M. ZOSS
Technical Training Director
Application Engineering Dept.
Taylor Instrument Cos.

THE RECENT TREND to automatic control of complex industrial processes, coupled with the increasing use of office machines and computers for performing such operations as accounting, inventory and design, has clearly pointed out to the control industry the need for better information handling equipment. The usual practice of manually converting the information on chart records to punch cards or tape not only wastes time and manpower, but is also subject to error and opinion since human operators are involved. However, to simply build and produce equipment that would take the signals from the various variables and convert these signals to punch cards or tape, is not the answer. The true need is not only for information handling equipment, but more important is the need for a complete information center. The Taylor Trans-Scan-Log Control System answers this need, for it has been engineered and designed as an information center.

In analyzing any product it is best to start out by specifying our needs. The product may then be examined to see if it satisfies each of the specifications. In the particular case of an information center, a review of the development of industrial process control supplies us with the material to set forth the following specifications: (1) Compactness to meet minimum space requirements and provide easy operator supervision, (2) ability to produce complete co-ordinated knowledge of process activity, (3) provide reliable data in usable form and (4) adaptability. We may now proceed to examine the TSL System on the basis of our specifications.



TRANS-SCAN-LOG system of Taylor Instrument Cos. provides for easy operator supervision. Normal 20-foot graphic panel can be compressed into a 5-foot panel.

The first requirement is *compactness to meet space requirements and provide easy operator supervision.* The graphic panel section of a TSL System, because it does not have to

provide space for the insertion of indicating or recording receivers on the process flow diagram, can easily compress a normal 20-ft graphic panel into a 5-ft section. The instrument panel requires only enough space to accommodate the fronts of the indicating and recording receivers. Numbered lights on both the graphic panel and its corresponding indicator or receiver instantly relate one to another, placing before the operator a complete process picture which may be observed in a single exposure. This concise grouping definitely aids supervisory personnel.

The second requirement demands *ability to produce complete co-ordinated knowledge of process activity.* In the TSL System, variables are scanned at the rate of one point per second and the operator is notified by both audible and visual alarms of any off-normal condition. As a result of the coding system using the numbered lights (white for normal; red for above normal; and amber for below normal) the direction of the necessary correction to overcome troubles is immediately known. In the case of an off-normal variable, the signal is also digitized and automatically logged either on an auxiliary column printer during a scanning cycle or on the data sheet during a logging cycle. The operator then not only knows the direction of the necessary correction as indicated by the signal lights but also the magnitude of this correction.

Logging of all variables at the rate of one every two seconds may be programmed for any time cycle. However, on-demand logging of any point or continuous logging of all variables is available at any time to the operator at the control desk by pressing station selector or demand log buttons. Easy interchange of recorders and indicators on the instrument panel allows recording of any point. Spare trend recorders with plug-in features may be used for points that are not normally indicated or recorded. The operator in this way has before him the apparatus to maintain a logical co-ordination between the information received and the actual process.

The third requirement calls for *reliable data in usable form,* which is directly tied in with our original problem of information handling. Since the TSL System reads only the value of the applied signal and cannot render opinions, the reliability of the data obtained is greatly increased.

With the TSL System the manual methods of preparing the data may be eliminated, since punched tape, magnetic tape, or direct signals may be obtained along with the typewritten record. This information is then in a form which may be acted on by computers to give accounting, inventory and design data. In this way we rapidly convert our information to usable knowledge, reducing our time lags from months to minutes.

The fourth requirement of *adaptability* is one that is sometimes overlooked. However, in pilot plant operation and in plants where future expansion is planned, changes in design can be expected and are often experienced. The elimination of costly cut-outs on the graphic panel and the availability of standard rack mounting of additional recorders and indicators makes the TSL System inherently capable of making such changes with little or no difficulty. As a result of this, costs are reduced.

Changes in the order of readout may be programmed to fit an specifications and can be easily changed by a simple process of replugging contacts. High and low limit plugs, based on the same principle, may be easily varied should process conditions or the variable be changed.

Having now completed our analysis, we can see that a complete information center is the real key to better control. Only in this way can we continue to produce improved product at reduced costs.

Instruments Control Instruments To Advance Process Automation

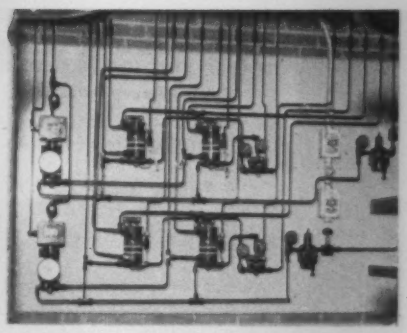
By D. C. SANFORD
Manager
Application Engineering Dept.
The Bristol Co.

INDUSTRY TODAY has become well aware of the part control instruments play in automation, and this part has even been recognized in a slogan, "Instrumentation Paces Automation". A new trend in instrumentation is taking place, however, in which automation is being applied to the instruments themselves, and we now find situations where one instrument is controlling another in its actions.

This automation of instrumentation is evident in such automatic control systems as selective control, relation or ratio control, and cascaded control, where one controller affects the operation of another controller to maintain two or more process variables which are compatible.

Briefly, the various control systems mentioned are used for the following purposes:

Selective Control: Automatically maintains two or more related process variables such as steam temperature and pressure at (or on the safe side of) their individual set-points by means of a single valve, diaphragm operator, etc. This single, final control element is selectively operated by separate measuring and control units through a pneumatic



SELECTIVE control installation at natural gas meter regulating station maintains the distribution system at, or on the safe side of, the maximum allowable flow rate or pressure. Equipment is manufactured by the Bristol Co.

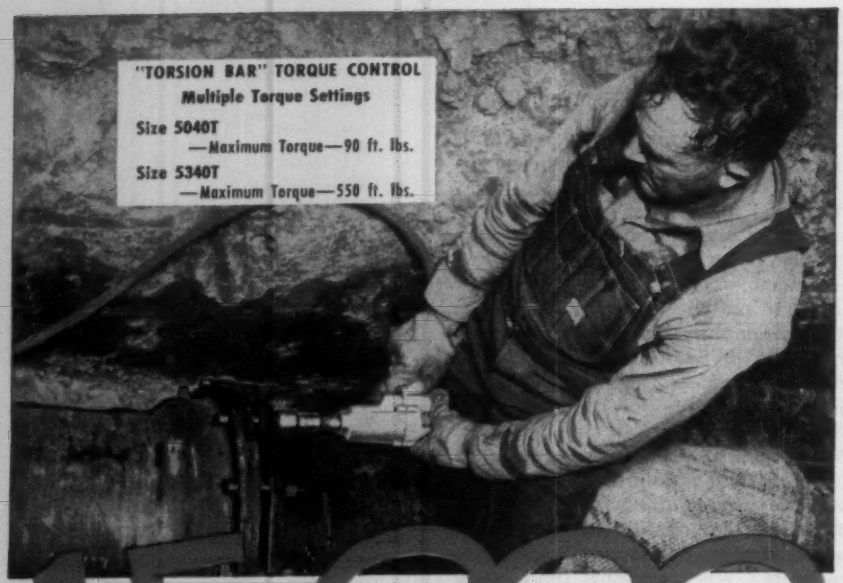
selector relay, and its position is determined by the variable which requires the greatest corrective action to maintain safe operating conditions.

One ideal application for selective control is on gas transmission lines where distribution takeoffs are installed, and where it is desirable to limit the maximum flow-rate to the distribution system, while also limiting the maximum pressure in the system. In this case, the flow must be controlled during high load periods, and the pressure controlled during low load periods.

Opening the control valve causes the measured pressure to increase; the measured flow also increases as the valve is opened. A low pressure selector relay governs which control system actuates the control valve to maintain the flow and pressure at or on the safe side of its set-point.

Cascaded Control: A system consisting of two or more series connected controllers, each of which contains a complete measuring and controlling system. The first, or master, controller measures the process variable which is to be controlled. The second controller, called a slave, or autoset controller, measures and controls a second variable which affects the value of the first. The two controllers are in the same control loop, and the output of the master controller regulates or readjusts the set-point of the slave controller, according to the value of the original "controlled variable". The primary benefit from the use of cascaded control systems lies in the elimination or reduction of time lags in the process.

Typical applications of cascaded control occur in petroleum refineries in the regulation of temperatures in reboilers. The master controller measures the temperature at one of the intermediate trays in the fractionating column, and its output air pressure automatically positions the set-point of the slave controller. The output of the slave controller regulates the rate



15,000

3/4" bolts uniformly tightened to 60 ft. lbs.

TORSION BAR with new Ingersoll-Rand

Torque Control IMPACTOOL

PROBLEM:	Assembly of 1390 mechanical pipe joints involved over 15,000 3/4" bolts. The problem was to speed assembly, remove guesswork and assure proper tightness of all joints.
AIR ENGINEERING SOLUTION:	A new Ingersoll-Rand Size 5040T Torsion Bar Torque Control Impactool, preset to deliver 60 ft. lbs., was put on the job.
RESULT:	The Torque Control Impactool automatically shut off at the preset Torque . all guesswork was eliminated . . . uniform joint tightness was produced . . . an average of 10 minutes per joint was saved . . . smaller bell holes were required due to compact size of the 5040T . this one tool produced an extra profit of $404.25 on this job.

You can put these new "Torsion Bar" Torque Control Impactools on your nut running jobs and reap these benefits: Positive Torque Control . . . Simple Torque Setting . . . Setting remains constant . . . No pressure regulators needed . . . No operator training.

Write or phone for a free demonstration of this revolutionary fastening development.

Ingersoll-Rand

B-344

11 Broadway, New York 4, N.Y.

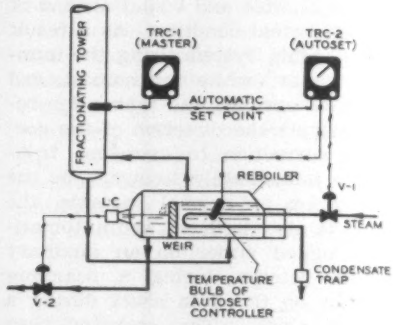
Circle 565 on Inquiry Card

of steam flow to the reboiler.

With this control system, quality changes in the controlling steam will not affect the temperature of the tray in the tower, and the controllability of the whole process is improved. Effects of time lags in heat transfer from the reboiler to the control tray are minimized.

Relation Control: A system which automatically maintains a predetermined relationship between two process variables. One variable is called independent or wild, and the other is known as dependent or captive. The value of the independent variable can be determined by some other controller, by action of the process, or by manual adjustment. It is outside the control loop.

Ratio control (the most commonly



SCHEMATIC of Bristol Co. cascaded control system which contro's the temperature of a fractionating tower through a reboiler.

used form of relation control) is most normally used for flow control, maintaining a fixed proportion between two gases or liquids, either into process vessels or furnaces, etc. It can also be used to control other process variables, such as the temperature, pressure, liquid level, etc., of one phase of a process which is in direct relation to another.

The use of these interdependent, or interconnected, types of control systems produces more uniform, satisfactory control in difficult-to-control processes.

The new, functionally unitized pneumatic instruments are designed for use in these control systems, as the three main functions of the control system are separated from each other, allowing rearrangement of the various elements in a variety of ways to fit the control problem at hand.

Prior to the development of these interconnected control systems, human observation was always necessary to correlate and adjust to make a process operate properly. With the control systems mentioned, difficulties and vagaries in human judgment are eliminated, and complete process automation has been advanced another step.

Industrial Process Control Dynamic Automation Industry

By P. S. DICKEY
President
Bailey Meter Co.

AS MANUFACTURERS of industrial process control equipment we describe our field of service as follows: "Manufacture and application of indicating, recording, and controlling instruments for those industrial processes which are primarily concerned with the conversion of basic materials into more useful forms.

If we measure service to industry in terms of value of products sold, this is probably the largest field of automation today. It is difficult to provide accurate figures as to the value of products sold, but if we include the principal categories of products used, namely, mechanical and electrical measuring instruments, scientific instruments, and control valves, we find that gross yearly sales increased 230 per cent in 6 years, so that we believe this segment of the automation industry has a growth pattern equal to or better than other areas.

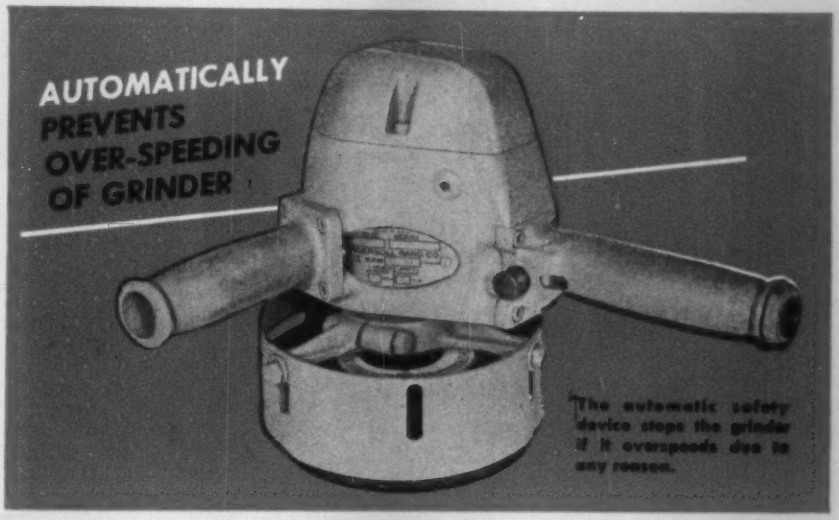
The expanding field of electronics has provided us with new components and new techniques which will open broader fields for measurement and control. However, improved designs and improved techniques for pneumatic and hydraulic measuring and controlling systems will enable these components to maintain their present competitive position in the field. Electric, pneumatic, and hydraulic controls each have their place; and relative economy, reliability and adaptability will determine which should be used.

Other new tools for industrial process control can be expected as technical proficiency increases. For instance, a better understanding of feed back principles and greater use of this technology will improve instruments, controllers, and control system performance. Better coordination of integrated systems of process control and better design of control centers will improve the reliability and efficiency of industrial process performance.

Use of digital devices for scanning, processing, and recording of process performance will open new fields for improvement. However, again, these devices will not replace the simpler, more reliable and less costly analog equipment except in certain areas. It is more likely that digital equipment will supplement rather than supplant conventional controllers.

The expanding markets for process control are too extensive for general-

NEW
THE ONLY
SURFACE GRINDER with a
POSITIVE SAFETY SHUT-OFF!



PLUS THESE OTHER COST-SAVING OPERATING ADVANTAGES:

- Handles can be set at 90° or 120° for close corner work and operator comfort . . . another Ingersoll-Rand FIRST!
- A responsive governor insures maximum cutting speed and minimum air consumption regardless of load.
- Single point lubrication, double-sealed wheel bearings, large oil reservoir for long life, low cost operation.
- Top of tool is flat for easy pressure application.
- Available in 2 Models and 4 speeds as follows:

  Speeds: 3100—4100—4500—and 6000 rpm.

  Size 41F with push-locking throttle for constant operation.

  Size 41FX with self-closing, safety type throttle.

Ask for a demonstration of this new safety grinder in your shop.

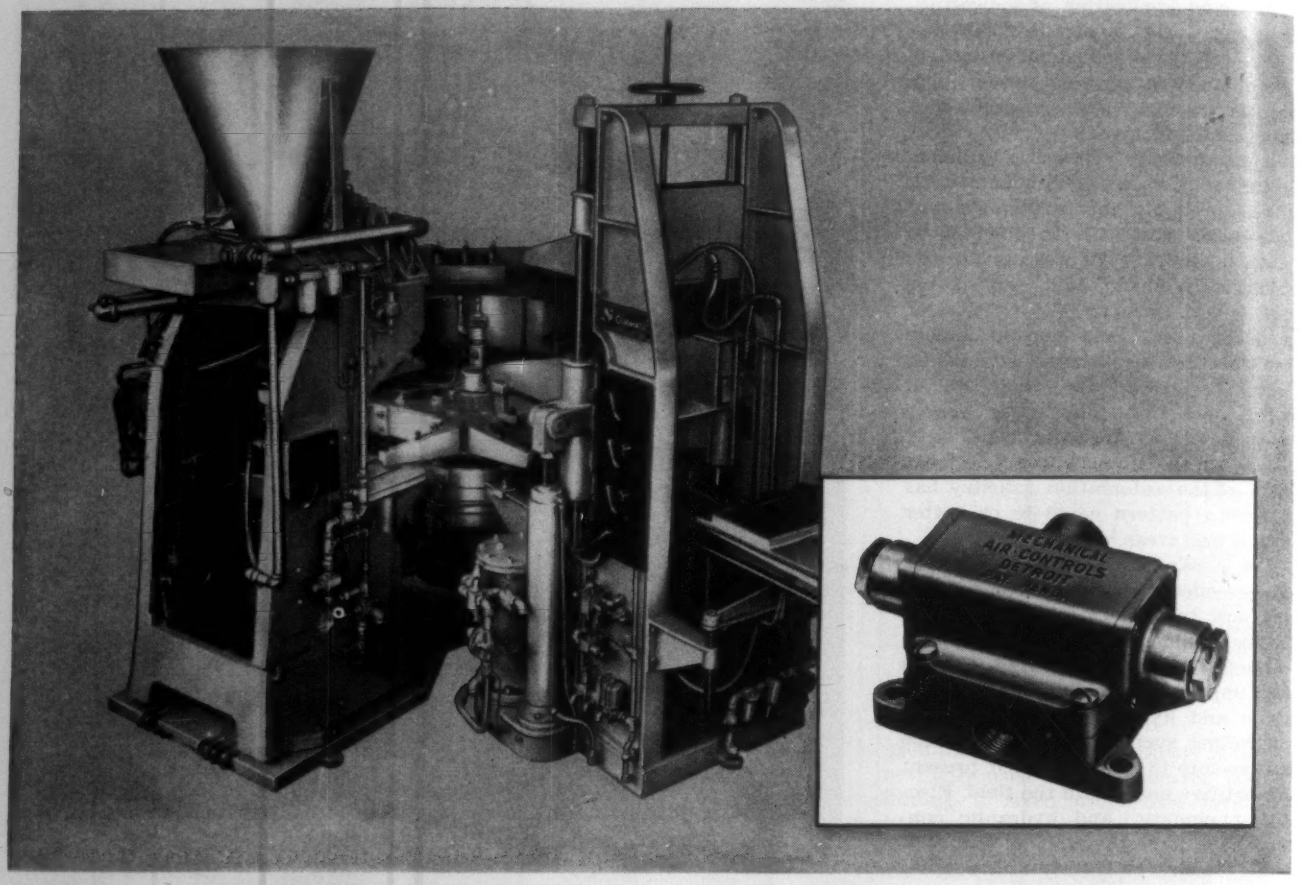
S-343

Ingersoll-Rand

11 Broadway, New York 4, N.Y.

Circle 566 on Inquiry Card

1200 SHELL CORES AN HOUR... and AIR DOES THE WORK



AUTOMATION COMES TO FOUNDRIES with Beardsley & Piper's new "Cormatic". Its intricate *all-air* control circuit features 33 MAC valves . . . provides the split-second operation needed to produce up to 1200 close-tolerance shell cores an hour using multiple core boxes.

MAC valves are showing up everywhere . . . and showing up well.

A glance at the "Cormatic" above illustrates the point. Here, on the latest in foundry equipment, 33 MAC air valves are used. You may be sure they'll endure the test of dust, dirt and moisture . . . perform with precision and reliability for millions of cycles.

Why not check MAC for all *your* original equipment and replacement needs? You'll find MAC valves light and compact . . . and with fewer parts to wear or cause trouble. It's one of the most complete lines in the industry, too—a wide range of sizes in pilot, pilot-operated and solenoid models.

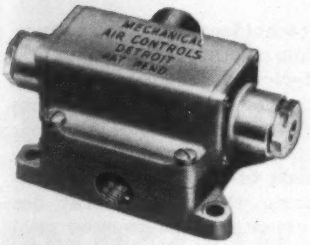
Contact a MAC field representative, listed at the right, for an assist on any air control application. Or, for free literature, write to:

MECHANICAL AIR CONTROLS, INC.

Office and Factory—10030 Capital, Oak Park, Detroit 37, Michigan

MAC

Circle 567 on Inquiry Card



PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., Kimball 8271

COLORADO (and NEW MEXICO, UTAH, WYOMING)
DENVER 16—Blair Engineering Co., 4100 Grape St., FLorida 5-7142

ILLINOIS
CHICAGO 43—Mike C. Modrich Co., 10918 South Western Ave., HIlltop 5-3640

INDIANA
FORT WAYNE 3—Neff Engineering Co., P.O. Box 2001, Station A, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 20—Neff Engineering Co., P.O. Box 7361, 42nd St. Station, BRoadway 2330
SOUTH BEND—Dick Futter, 103 South Varsity Dr., CEntral 2-3800

MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 Chilson St., 2-2629
FLINT—Kober Sales Engineering Co., 514 Beach St., CEdar 8-5123
Western Michigan—Everett Adams, 17212 Sharon Road, Chesaning, Michigan; Chesaning 383-J-1

MINNESOTA
MINNEAPOLIS 4—Air Engineering & Supply Co., 2445 Nicollet Ave., FEderal 9-5579
ST. PAUL 14—W. H. Schulz Co., 2438 Franklin Ave., MIdway 4-2791

MISSOURI
ST. LOUIS COUNTY—Oscar E. Jost Co., P. O. Box 6, St. Ann, HArrison 8-4488

NEW JERSEY (Northern)
CRANFORD—The Roden Company, P. O. Box 305. CRanford 6-7330

NEW YORK
BUFFALO 21—C. H. Tepas Co., 200 Washington Hwy., CIrcle 3210

OHIO
CINCINNATI—The R. W. Nichols Co., Fidelity Federal Savings Bldg., 2087-9 Sherman Ave., Norwood, ELmhurst 1-2440
DAYTON—The R. W. Nichols Co., 407 Realty Bldg., MIchigan 4724
OLMSTED FALLS—The R. W. Nichols Co., P. O. Box 6, BErea 4-1379
TOLEDO—R. W. Nichols Co., 510 Manhattan Building, Toledo 4, CHerry 1-1447

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., BEacon 0205

PENNSYLVANIA
PHILADELPHIA—Grand Air-Hydro Co., P.O. Box 141, Glenside, TUrner 7-4296
PITTSBURGH 22—The R. W. Nichols Co., 101 Investment Bldg., ATlantic 1-6050

TEXAS
DALLAS 19—Womack Machine Supply Co., Shea Rd. at 7150 Harry Hines, FLeetwood 7-3871

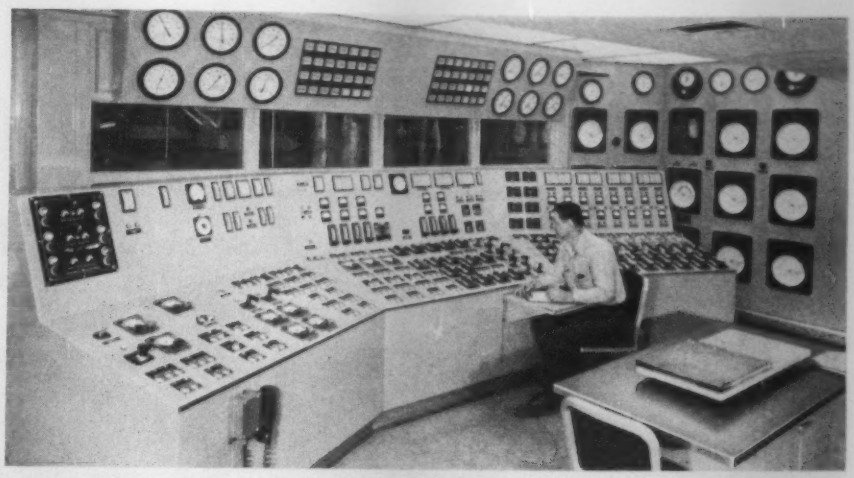
WASHINGTON
SEATTLE—The Rucker Co., 1000 4th Ave., South, MAin 2783

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 N. Pt. Washington Rd., EDgewood 2-1579

CANADA
ONTARIO, HAMILTON—Higginson Engineering Sales. P.O. Box 23 (275 James, North), JAckson 9-2262

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN

MAC



CENTRALIZED steam control room in new power plant contains instruments by Bailey Meter Co. which provide automatic control during all normal conditions and permit manual control for start-up, emergencies or other off-normal operations.

izations to be made. However, consideration of a few examples will suggest the scope and importance of controls to industry in general.

In the primary metals industry demand for increased production, improvement of products quality, need of using lower grade ores and elimination of waste, provides unlimited opportunities for industrial process control.

In the field of power generation, use of increased pressure and temperature and increased size of generating units, plus the need for burning lower grade fuels without reducing the effectiveness of heat transfer equipment and contamination of the atmosphere, pose broad and continuing opportunities for the industrial process control engineer.

Many areas in our country are rapidly becoming conscious of the shortage of our most important life-giving resource, namely uncontaminated water. Treatment of water and waste is becoming a major activity and opportunity for industrial process control.

We must keep in mind that even with these new tools in these expanding areas of industrial process control, the progress of automation is first limited by our ability to pay for it.

Secondly, controlling devices, complex or simple, can be no better than the measuring devices which guide their performances. There is a need for improved sensing and measuring devices in every field of automation.

The third limitation is the risk of loss of production due to failure, or to normal maintenance schedules, required for automatic devices of great complexity. While the investment for production equipment may be from 10 to 50 times that of the controls which make it automatic, control equipment must be more reliable than the production machinery if substantial losses are to be avoided.

The final limitation will be found where we attempt to replace the experience and judgment of human supervisors with machines. It is usually practical to replace human operators on highly repetitive functions, and frequently machines can accomplish specific operations far better than human beings, but for over-all supervision of a production process, or for infrequent special operations encountered during start-up, emergencies, etc., the judgment and skill of an experienced human operator is the most economical device which has yet been created.

Wider Use of Instrumentation—Prelude to Tomorrow's Automation

By J. C. MELCHER, Head
Instruments & Systems Div.
Market Development
Leeds & Northrup Co.

HOW NEARLY can we achieve the full use of instrumentation in industry? As a manufacturer of electrical instruments, automatic controls, and heat treating furnaces, Leeds & Northrup is working hard on several facets of this problem. Present company thinking is broadly reflected in the theme for its exhibit at the September Instrument Society of America instrument - automation conference where recent L&N developments are presented as the "Prelude to Tomorrow's Automation."

Developments in the instrument field usually provide at least one of the following features: (1) *Better measurement* — for increased accuracy, for new variables, or under more difficult operating conditions; (2) *better control* — by improved controller performance or by applica-

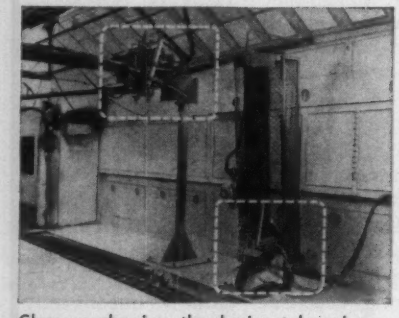
Binks automatic reciprocating spraying machines installed in the Chrysler Division, Kercheval Plant Body Paint Shop, Detroit, Mich.

automatic spray painting assures quality finish

for CHRYSLER'S "FORWARD LOOK"

Lustrous, durable finishes, for which Chrysler cars are famous, are applied automatically by specially designed Binks reciprocating spraying machines. Placed at each painting station are Binks vertical and horizontal automatic reciprocating machines. Model 21 automatic spray guns mounted on curved tracks follow the body contour.

Actuated and controlled by the movement of auto bodies down the line, these machines apply a uniform finish with little material waste. If a body is missing in the line, the spray guns do not operate.



Close-up showing the horizontal and one of two vertical reciprocating Binks spray guns at each painting station.

These benefits can be yours
Binks automatic equipment can be designed to coat or finish almost any mass produced part or product ...and do it better, faster and at lower cost.

Free analysis and engineering help
If you would like to know what production rates or costs you could obtain with Binks automatic equipment, Binks research department will run actual tests on *your* products and supply you with a detailed report. Just call your nearest Binks Branch Office or write us direct.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

Binks
EVERYTHING FOR SPRAY PAINTING

GUNS

SPRAY BOOTHS

Visit us at the National Metal Congress and Exposition
BOOTH 2755

Binks Manufacturing Company
3132-40 Carroll Ave., Chicago 12, Illinois

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

Circle 568 on Inquiry Card

tion techniques, such as cascading of controls or other interlocking of units; (3) *better overall systems* — the combination of groups of measuring and controlling instruments into completely automatic systems, including newer methods of data presentation.

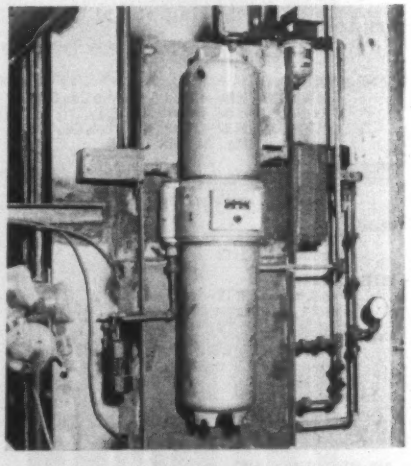
During the last several decades, instruments have assumed gradually increasing responsibilities in industry, while processes have increased in complexity and size. In leap-frog fashion, instrument users and manufacturers have worked together to bring needs and developments into balance. Measurement, still the foundation of all control, has progressed far from the ingenious but relatively crude devices once used for spot checks of a few variables at selected points in a process.

Knowledge of chemical concentration or analysis in process streams is increasingly important in many industrial applications. Direct analytical measurements during process operation can frequently improve efficiency and, at the same time, control product quality.

Continuous oxygen measurement in gas streams has long been recognized as the important key to efficiency of combustion of all types of fuels. Through improvements in magnetic oxygen analyzers and sampling systems it is now possible to integrate oxygen analysis directly into combustion control systems as basis for automatic fuel-air ratio control.

Continuous infrared gas analysis, freely used in chemical industries for product analysis, has recently been adapted for controlling the atmosphere in heat treating furnaces. This offers means for improving the annealing, carburizing and hardening of steel through measuring CO, CO_2, and CH_4 content in the furnace atmosphere.

Much of our progress beyond today's frontiers in instrument control depends upon a fuller understanding



INFRARED gas analyzer manufactured by Leeds & Northrup Co. permits continuous monitoring of stream flow.

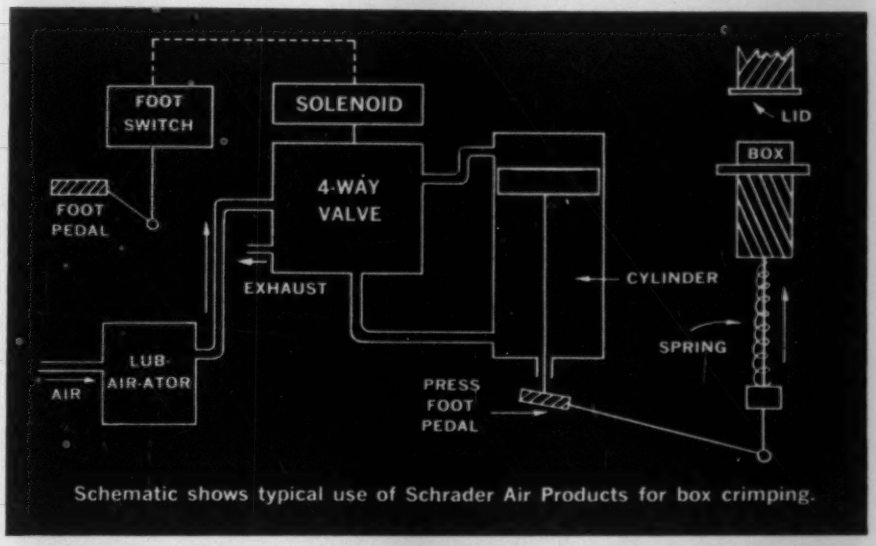
Progress Report:

HOW SCHRADER AIR PRODUCTS HELP INDUSTRY USE AIR IN AUTOMATION

● More and more manufacturing plants are using air for efficiency and economy

Air has always been an industrial tool, but its efficiency and economy are only being fully realized in recent years. Today, as industry takes giant steps toward automation, new ways of using air for automatic operations are being planned, tested and integrated into sequences in many different kinds of manufacturing plants.

Sometimes, when operations are automated, the "work" must be held and positioned—or moved—and scraps or chips cleared away. Other movements can be synchronized automatically. By adopting these and other variations to make the steps automatic, more efficient operation can be obtained. In many cases, this can be done more economically with Schrader Air Control Products than in any other way.



Schematic shows typical use of Schrader Air Products for box crimping.

FOR EXAMPLE:

● Schrader Air Products perform 5000 crimping operations per day

The accompanying schematic drawing refers to a common operation performed by compressed air: box sealing. One example of how air has made this operation more efficient can be seen at a New York arms manufacturing plant. The use of air compression there has eliminated back-breaking foot power, reducing operator fatigue and simplifying the operation. With air power, 5000 boxes per day are sealed. This kind of economy and efficiency is basic with air. In many cases it has made the difference between profit and loss.

● Safety margins are widened by use of special Schrader control techniques

Safety is built into Schrader Air Products. Their simplicity makes it easy to adapt techniques and features to operations with minimum cost and maximum effectiveness. Easy finger-tip and tip-toe operation of tiring hand and foot movements. Fatigue is reduced and production stepped up, with greater safety. Schrader has developed packaged control sets to such a degree that much of the hazard of press operation is eliminated. Two-hand controls are designed so hands that feed the press must also operate the press. Both hands must be used simultaneously and cannot stray into danger zones when rams come down. Special controls can be worked out to provide safer control for shears, brakes, friction clutches and any machine using a mechanical clutch.

● Schrader engineering facilities are available to help you

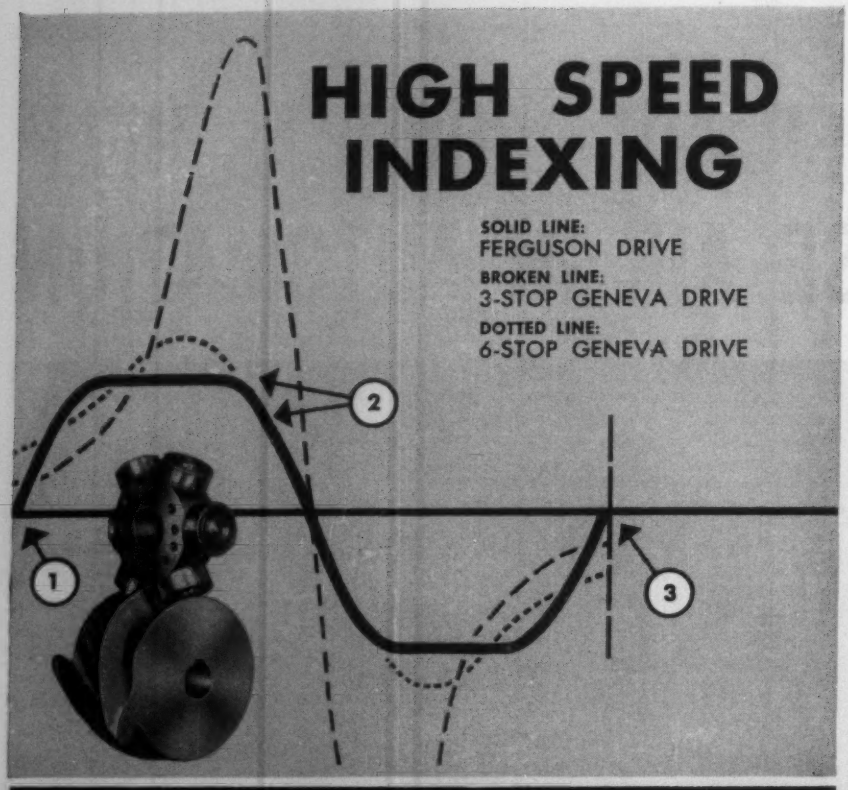
Upon request, Schrader engineers will assist in planning for the most efficient use of air in your plant, and in selecting the products best suited to a given application. Distributors are conveniently located to deliver Schrader Products in the shortest possible time. Today, these products are being turned out in mass production quantities for scores of industries. New products are also being designed constantly as acceptance of Schrader's know-how grows.

Write to Schrader for information.

Address A. Schrader's Son, Division of Scovill Manufacturing Company, Incorporated, 472 Vanderbilt Avenue, Brooklyn 38, N. Y.

Schrader®
ESTABLISHED IN 1844

FIRST NAME IN THE USE OF AIR
FOR INDUSTRIAL PRODUCTION AND CONTROL



FERGUSON DRIVES *vs.* GENEVA DRIVES

MODIFIED TRAPEZOID ACCELERATION CHARACTERISTIC OF THE FERGUSON DRIVE PERMITS SPEEDS UP TO 1,000 INDEXES A MINUTE!

The acceleration diagrams above show why it is practical to operate the smooth indexing Ferguson Drive at a rate far beyond that of the obsolete geneva drive. As every engineer knows, the geneva limits the speed of production machinery . . . the clanging, banging and jarring wears out the geneva drive and the machine, and affects product quality.

Now see how the Ferguson Drive differs!

1. *The Ferguson Drive has an initial force of zero with a sinusoidal increase . . . the start of the movement is smooth.* Genevas have instantaneously applied dynamic forces, followers "crash" into slots, whatever accuracy existed is soon lost.
2. *The Ferguson Drive, utilizing a combined cycloidal and gravity curve, has a very low maximum acceleration value with a gradual change to maximum deceleration.* The geneva has a high maximum acceleration value with an almost instantaneous change. Vibrations from the geneva drive decrease efficiency of the machine and create a need for excessive maintenance.
3. *Deceleration and stopping of the Ferguson Drive is gradual.* Geneva drives decelerate suddenly . . . they practically "jerk" to a stop and the shock is tremendous at high speeds.

Differences in precision, life expectancy and design versatility of the two types of mechanisms are equally striking. They are discussed in our new Catalog 106 on STOCK AND STANDARD FERGUSON DRIVES. Send for your copy if you are an engineer interested in learning about high speed indexing methods.

USE THE FERGUSON DRIVE FOR INDEXING DIALS, ROLL FEEDS, CARRIERS & CHAIN . . . WHEREVER YOU NEED HIGH SPEED, PRECISION INDEXING

ferguson

FERGUSON MACHINE CORPORATION

ROLLER GEAR DIVISION, DEPT. A-9, P. O. BOX 5841, ST. LOUIS 21, MO.

Circle 570 on Inquiry Card

of newer control concepts on the part of management and production men in industry. Servomechanism techniques, used to solve military control problems, have brought system analysis methods to the instrument field which are still being developed by both instrument users and manufacturers alike.

This system approach emphasizes the close relationship between process and controller characteristics — both of which influence the controllability of the process. The process is largely the province of the instrument user, requiring study and data that the plant designer can best supply. Developments in L&N system control equipment include several basic designs which are suitable for general control applications, and a number of systems developed specifically for certain industry needs.

For industrial processes where pneumatic valve operation is desired, L&N has developed a new electropneumatic control system. This system provides electrical measurement of the variable, such as temperature, by means of a Speedomax electronic instrument, and automatic control with three-action proportional, automatic reset, and rate. An electropneumatic converter changes electric current input into an air output which actuates the pneumatic control valve.

In keeping with trends toward instruments which scan a large number of process points but do not continuously record all of them, L&N has developed an instrument system, termed Auctioneering Control. This system is based on a multiple point temperature recorder, a standard single-point recorder-controller, and a switching unit. Originally developed for control of a chemical process, the system continuously seeks the highest (or lowest) temperature point among many primary elements and automatically switches control of this point to the single point recorder-controller. It offers a compact, relatively low-cost method of monitoring large numbers of process variables and controlling for optimum conditions.

Few processes present more difficult control problems than a nuclear reactor. Power levels can change rapidly over some seven decades of values; the process possesses no "capacity" to stabilize control action; and the system must have fast "scram" for certain unsafe conditions without unnecessarily interfering with operation at other times.

For reactors, L&N has developed a "package" control concept which includes design of the overall control system, production of major components, and purchase of other components to be integrated in the complete "package." In the L&N package ap-

DIFFICULT control problems for nuclear reactors have led to development of complicated systems to assure safe operations under all conditions. The illustrated "package" system is manufactured by Leeds & Northrup Co.

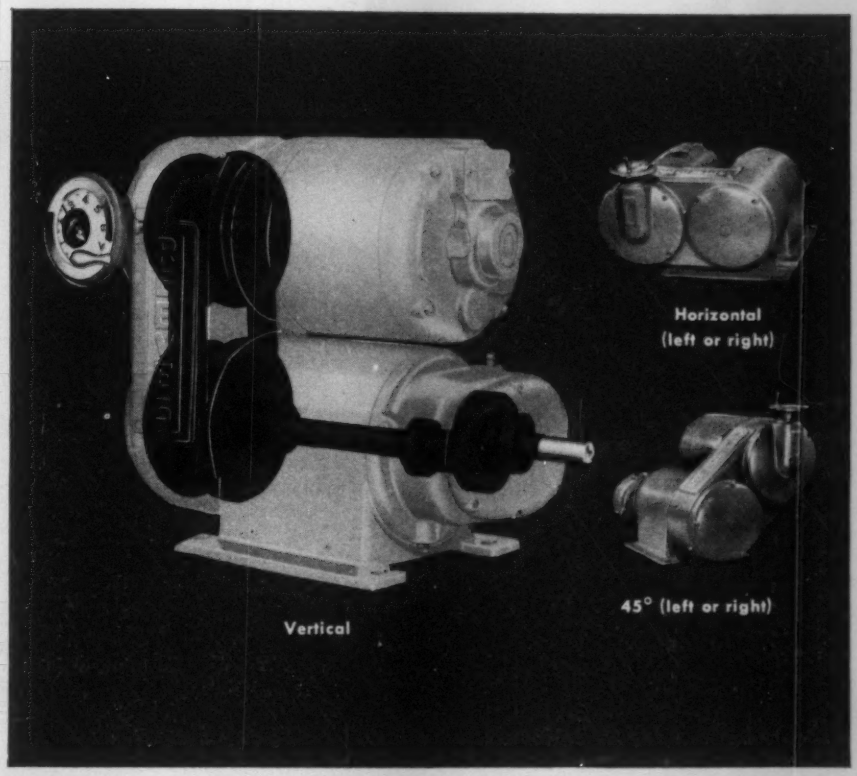
proach, separate systems, called channels, guide reactors through such typical operations as initial start up, intermediate power build-up, and automatic control at the operating level. Additional channels provide for slow, intermediate, and fast scram.

For larger and more complex plant operations, data processing systems and computers are finding increasing use. As practical methods develop, industry finds such equipment to be economically justified on the basis of improved operation, better intelligence in the hands of plant operators and management, and useful data stored for later plant studies and accounting procedures. In general, the new systems provide condensation of data in usable forms — such as printed log sheets, IBM punched cards, or electronic tape recordings — and present means for rapid processing and interpreting of data.

For the logging of voluminous test data by an aircraft manufacturer, L&N engineers developed a system to simultaneously print out 12 different channels. Twelve Speedomax G recorders are equipped with Giannini Encoders which convert electronically measured variables into digital values. In addition, each reading, taken at the rate of up to 100 times a minute, is punched in code on an IBM card for file, to be used later in analyses of the logged data.

Future progress in instrumentation will follow the general lines of the recent path. New technology in many fields will be quickly adopted by the instrument industry. New and better measuring means, and improved control devices will produce better integrated and more completely automatic system of instrumentation. Continued close co-operation between manufacturers and users can accelerate progress, to the mutual advantage of each.

Variable Speed – Styled For Compact Machine Designs

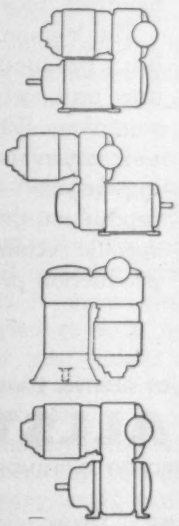


REEVES

FRACTIONAL *Vari-Speed* MOTODRIVE

WHERE DO YOU NEED THE OUTPUT SHAFT?

Motor side, control side, or vertical down



▶ REEVES fractional hp. Motodrive is a complete power package, engineered in over 100 assemblies to fit wherever your design calls for variable speed.

Choose from vertical, 45° or horizontal models in ¼ to 1 hp. . . . get stepless accurate speeds—within a 2:1 to 10:1 range—from as low as 3 rpm to a maximum of 4660 rpm.

Available in standard, weather resistant, totally enclosed or splash-proof enclosures; full range of manual or automatic controls.

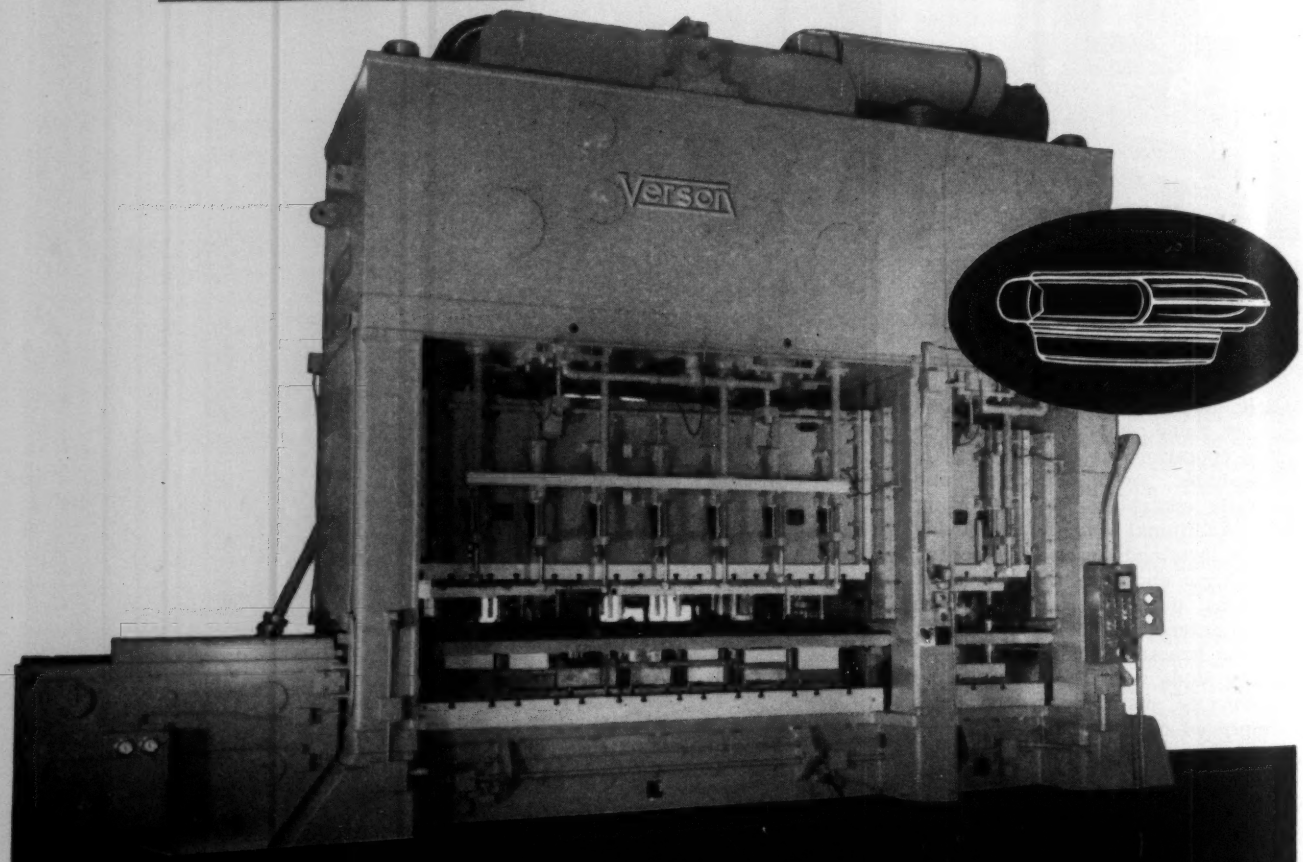
REEVES Motodrive—the *right* speed for *every* need . . . in *any* place.

Write Dept. AN23-M543 for ratings and dimensions.

REEVES PULLEY COMPANY
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.
Columbus, Indiana

Circle 571 on Inquiry Card

this Verson TRANSMAT PRESS



is producing 1000 automotive air cleaner shells per hour automatically

In another cost cutting production process engineered by Verson, this 900-ton two-slide Transmat press completes 1000 air cleaner shells every hour without human handling. The intricate part is formed from coil stock in eight consecutive operations.

Verson Transmat Presses offer unusual economy and efficiency whenever four thousand or more pieces, requiring four or more operations, are produced per day. Essentially a single press with multiple die stations and separately adjustable slides, the Transmat transfers the work piece by mechanical fingers synchronized with the press action. Feeding can be from coil stock or blanks. Intermediate handling, pickling or annealing is unnecessary.

The Verson Transmat is more than a press . . . it is a production process that can substantially reduce unit costs on a wide variety of mass produced stampings. Whatever your requirements, however — from several hundred to many thousand stampings per day — we will be happy to recommend the production process best suited to your needs. For specific recommendations, send an outline of your production problem.

A Verson Press for every job from 60 tons up.

Verson

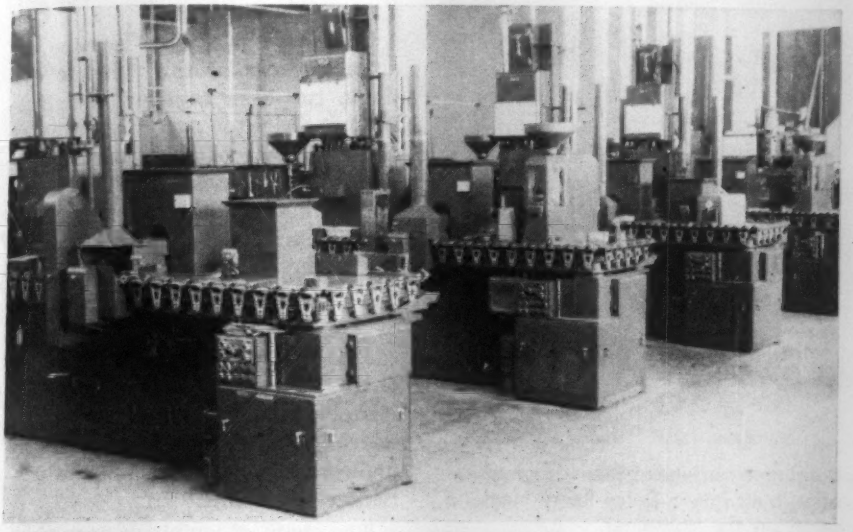
ORIGINATORS AND PIONEERS OF ALLSTEEL STAMPING PRESS CONSTRUCTION

VERSON ALLSTEEL PRESS CO.

9322 S. KENWOOD AVENUE, CHICAGO 19, ILLINOIS • SO. LAMAR AT LEDBETTER DRIVE, DALLAS, TEXAS

MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES • TRANSMAT PRESSES • TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES

By JAMES C. KEEBLER
Associate Editor



Battery of automatic packaging machines used by Delco-Remy packages automotive electrical parts. A single operator loads and unloads each machine which automatically imprints identification data, shapes the can, drys the ink, loads the parts, check weighs quantity loaded and inserts and seals the cap.

Sold In A Package

LAST MONTH Buick announced that their four-door hardtops were going like hotcakes. In a matter of 16 months since the introduction of this style of body Buick built its 300,000th four-door hardtop. Production for the first six months of this year was 218,000 four and two-door hardtops or approximately two thirds of Buick's total output.

This is a 1956 illustration of what Chrysler learned in 1934, Studebaker showed in '46 and the packaging industry (meeting in convention and exhibit in Cleveland this month) is telling people all the time—the package that you put it in makes a big difference in the sales of your product.

Permanent Package

This principle holds true whether the package is something that gets tossed in the nearest ashcan or something you ride around in until you buy an updated version. As a customer you buy the complete works, package and all, and how the package impresses you may well turn the sale.

Body stylists are also compromise artists since the processing engineers ability to devise an economical process to put wingdings on the contours and still get the parts out of the dies, largely determines the cost of manufacture. The product must be well engineered to perform dependably and be manufactured economically, but it must also be fashionably styled so it is not only palatable but also judged as tastefully designed by the big boss: Jack-the-Customer.

Importance placed on this is evidenced by the fact that the GM styling staff which 30 years ago had less than 12 members is now an organization of 1100 men and women. Even though the sleek vehicles are delivered to the dealer protected only by a canvas tarp, and though the customer takes it home without so much as a paper poke or a piece of string around it, still the packaging industry whose stock-in-trade is cardboard, paper, cellophane and glue manages to make a big contribution to the auto industry.

Packing and Packaging

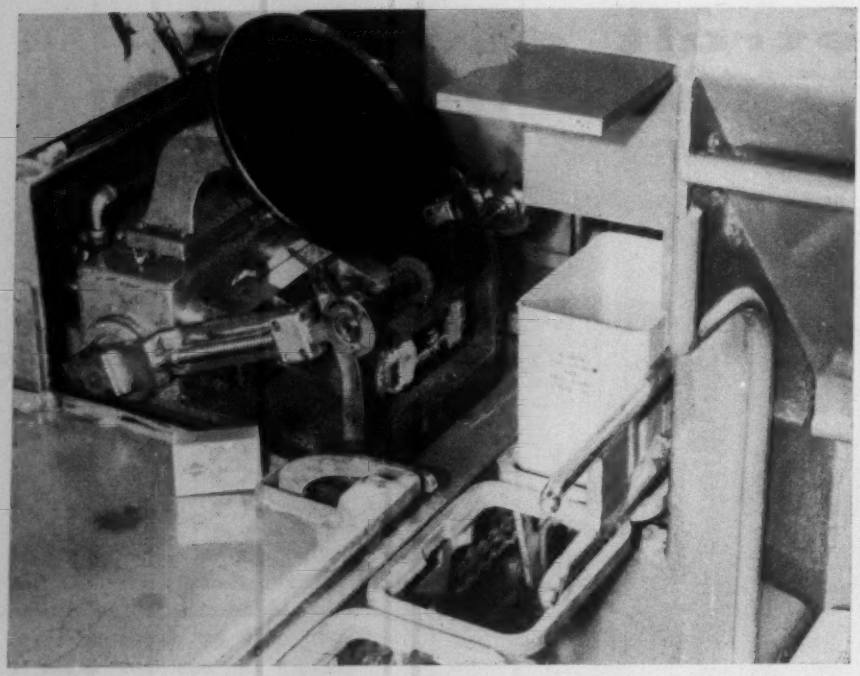
Big slice of this pie goes to the parts business. Chrysler Corp. has 12,000 suppliers in 1,402 cities of 44 states, the District of Columbia and 3 foreign countries. GM noted in totalling up its suppliers ("partners in production") that a direct supplier of molded nylon parts has 75 of its own suppliers.

The interlocking relationship of the auto industry to other industries is well known. But the increasing role that the packaging industry (including package materials, package machinery and packaging operations) is playing in auto production is an item worthy of note.

Parts makers are concerned with both packing and packaging. Original equipment parts are packed for shipment to the assembly plants while replacement parts are packaged for shipment to the jobber.

Packing for Automation

In this age of automation the emphasis being placed on processing techniques and assembly meth-



One important phase of an installation packaging a variety of items is provision for proper marking of the package. This station built into a Delco-Remy machine imprints part number, quantity and description on the container.

ods has led to a reappraisal of many of the old packing systems. A little extra thought, and even a little extra cost in the packing of the parts can present them to the buyer in a manner that makes them more readily accessible for his operations, and saves manufacturing.

This idea can be exploited all the way from the prepositioning of valves in their packing cases in such a manner that they are easily loaded into feeder chutes of a cylinder head assembly machine; to the purchase of bent brazing clips in magazine packs so that orientation of the open end need not be re-established by the user's department.

Having the packing means perform double duty for the buyer is an idea steeped in the finest automaking tradition. The story is told that Henry Ford bought parts in wooden boxes made of boards to specified dimensions with specified holes in specified locations, then he specified to his factory that these very boards were floor boards for his cars.

Today's multiple purpose packing usually serves its several roles in shipping and processing then lands in the scrap rather than in the dealer's showroom. Examples include springs in "egg crate" dividers that prevent snarling, and ribbons of small parts on pressure sensitive tapes for automatic feeding to production machinery.

Assembling the Package

Functions of the replacement parts package do not often include the need for supplementing the features of the users production process. But considerations often involve features such as: rust or corrosion protection, labeling for identification, weighing for check on complete filling, shape of package for stacking and display, and fashionable design for eye catching appeal.

Automated packaging equipment is a close kin to automated assembly machines. Many of the same principles and mechanisms apply to both. Components must be supplied, oriented, fed and assembled. Packaging machinery manufacturers are finding applications of their equipment in the middle of the production line as well as at the end: Dispensing measured quantities of powders, applying adhesives, and performing strapping and tying operations. Assembly machines are dropping their completed assemblies into packages. Limitations on the cross-application of principles seem to be only in the know-how and ingenuity of the processing engineer.

Packaging for Fashion

On the parts seller's counter the attractiveness of the package can jingle the cash register. Merchandising of auto parts contributes to the income of such master sellers as Sears Roebuck & Co. Their new tune-up kits reveal a flair for catching the eye and helping the sale.

Using the blister or bubble type of package to show off their wares these kits of ignition distributor parts consist of a clear plastic blister fastened to a printed cardboard back that identifies the makes and models of cars the particular assortment fits.

The chain of suppliers here gives an indication of the complexity of the packaging market. Eastman Kodak makes the plastic from which Paper Package Co. makes the blister and furnishes this and the cardboard to the Tungsten Contact Mfg. Co. who fills the packages with the parts for Sears' distribution. Each step provides opportunity for automation techniques.

Processing engineers with widely divergent experience are called upon to contribute their fair share of production knowhow. Mass production plastic formulation and processing serves this and other markets. Molding techniques are required to produce blister type covers at minimum cost. Packing the parts into the kits involves solution of sorting, selecting and placement problems for the number of possible combinations of parts to make up a specific kit are great indeed. Even warehousing and distribution costs must be included in the price of sale. The Thresholds of automation are broad. There's much work to be done.

From manufacturing to selling there are plenty of chances for the auto industry and the packaging industry to help each other achieve greater sales in this booming economy.

Circle 630 on Inquiry Card→

It's Not Automatic

Fundamental factors in attaining the economic advantages possible through automation are overall top management understanding and program co-ordination. By and large, the level of co-ordination typically suitable with conventional manufacture falls far short of the mark. Few manufacturing engineers can exercise the necessary breadth of authority, instill the needed incentive, or command the required variety of information.

Experience has shown it is not enough to merely decide that perhaps automation may prove useful in certain operations. Some reorganization and long-range planning may be the only effective approach. From careful study of problems posed by engineers in various industries Frank Zagar, president of Zagar Inc., concludes:

"It seems that only top management can fully appreciate the economic worth of automation and, as such, top management will have to be the driving force to make sure that their subordinates do not take the easy roads to conventional methods. The excuses most stated for bypassing the economics of automation are such as, 'We don't have enough money—Our quantities are too small—We don't have enough time—We have too many engineering changes—Our product is unstable—We don't have enough volume—We don't have the technical experts — Our product doesn't lend itself to automation,' plus others in various degrees of the same. Any excuse is given to bypass automation and keep using conventional means and conventional thinking in solving various production problems.

"The first step in the approach to any automation planning *must be* one of economics. Therefore, automation is first studied from the standpoint of where money can be saved. In many instances, it can be saved only by treating an entire complex product as one production problem instead of by separate components as in conventional thinking."

Successful pursuit of continuous automatic production in any degree requires something more than the conventional authority in manufacturing engineering. Product and process responsibility must be integrated and a radically new approach to process planning developed. Whether the need is merely for a "poor man's" transfer machine or a fully automatic production system, the real dollars and cents results that can be attained are not automatic—they require a higher level of management planning and engineering integration.

EDITOR

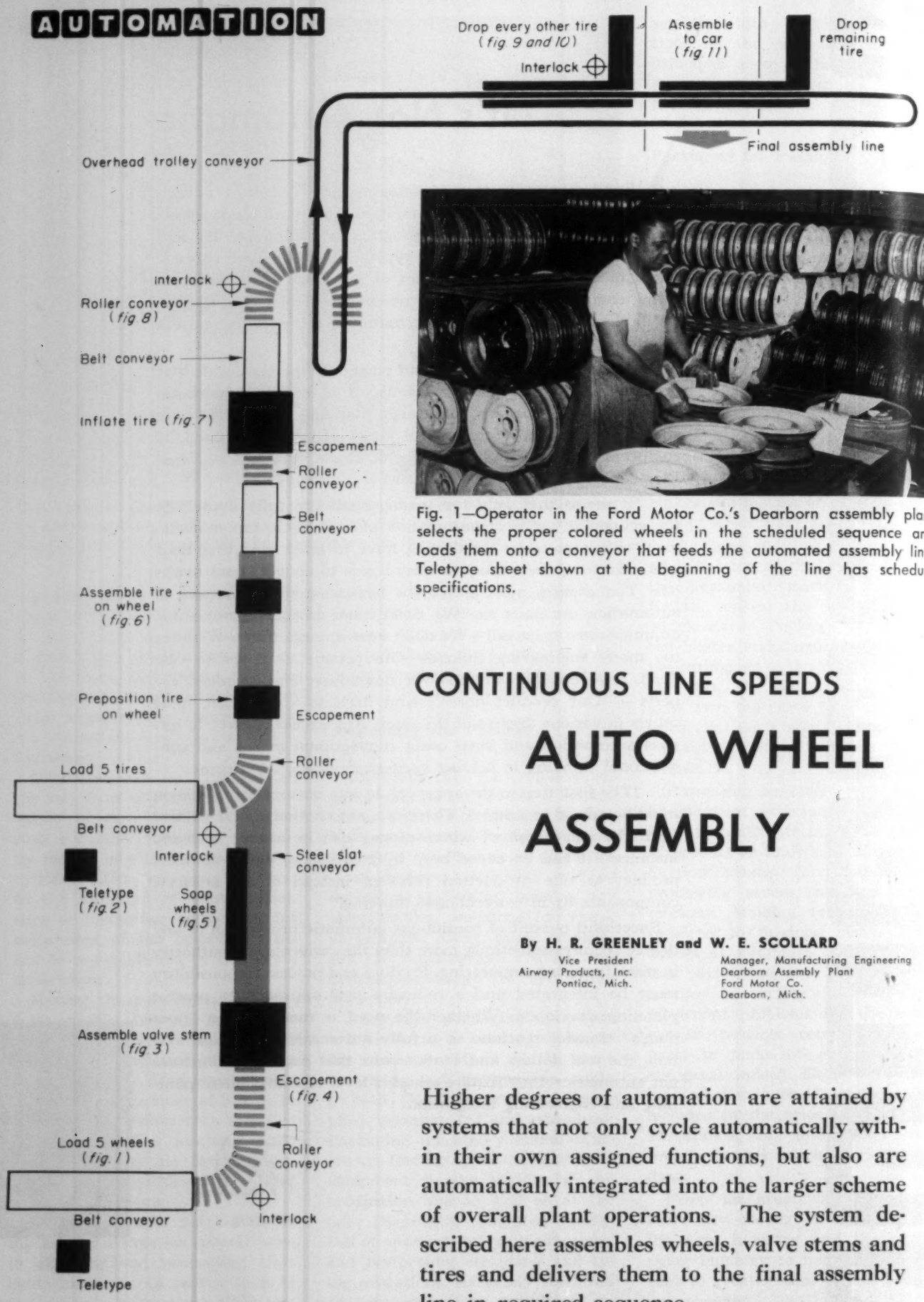


Fig. 1—Operator in the Ford Motor Co.'s Dearborn assembly plant selects the proper colored wheels in the scheduled sequence and loads them onto a conveyor that feeds the automated assembly line. Teletype sheet shown at the beginning of the line has schedule specifications.

CONTINUOUS LINE SPEEDS

AUTO WHEEL ASSEMBLY

By H. R. GREENLEY and W. E. SCOLLARD

Vice President
Airway Products, Inc.
Pontiac, Mich.

Manager, Manufacturing Engineering
Dearborn Assembly Plant
Ford Motor Co.
Dearborn, Mich.

Higher degrees of automation are attained by systems that not only cycle automatically within their own assigned functions, but also are automatically integrated into the larger scheme of overall plant operations. The system described here assembles wheels, valve stems and tires and delivers them to the final assembly line in required sequence.

WHILE MANY manufacturers look upon automobile makers as lucky automaters, favored with advantages of low-variety high-volume production requirements, closer scrutiny of the vast combinations of color and styling offered the customer reveals that final assembly operations are accompanied by problems of high variety co-ordination. The day has long passed when an automaker could compete successfully and supply only one model of body style in one choice of color.

All branches of components supply must merge at the final assembly line in a manner that will facilitate putting together the right combination of parts as required by the production schedule. Systems used here must provide flexibility of scheduling and automatic production integrated with the final line.

Subassembly Problem

The system of automatic assembly of tubeless tires to wheels developed by Airway Products engineers working in conjunction with Ford Motor Co. manufacturing engineers is an excellent example of how the production needs of the Ford organization are being accomplished. Any given production unit may have tires of a selected size from a choice of manufacturers and be scheduled to have either black or white sidewalls. Wheel colors are selected to match or complement the body colors and are put into the system as required by the production orders.

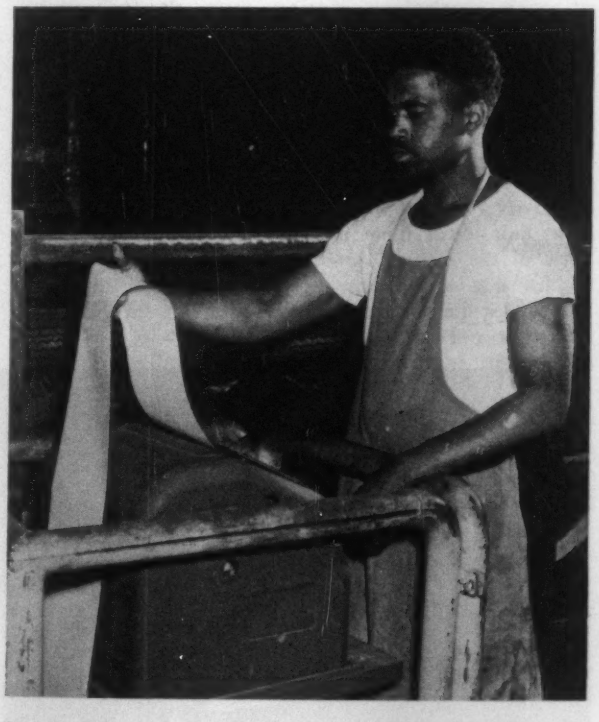


Fig. 2—Teletype receiving stations in the wheel and tire storage areas provide sequence information. Tire selections of type, size and sidewall color are coded for each car.

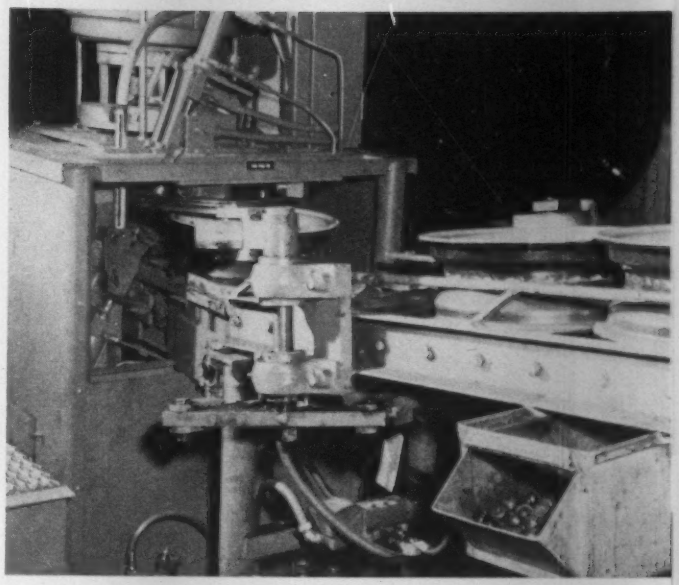


Fig. 3—Wheels are fed one at a time into a valve inserting machine from a gravity roller section by means of a limit switch actuated escapement device.

Beginnings of this subassembly line are in the wheel and tire storage areas where operators place these items on flat belt conveyors to start them into the system, *Fig.* 1. To accomplish the right selection sequence each of these work stations is equipped with a Teletype receiving station, *Fig.* 2, that prints the complete specification codes for each automobile that is being assembled. Routine at the wheel loading station is to refer to the tape, identify and circle the code for the next car, select five of the proper wheels from the storage racks, place them on the conveyor, and check off the item on the tape. An identical routine is followed at the tire loading station. Since the material on these lines will converge in sequence, the proper combinations of wheels and tires will reach the proper car on the final assembly line so long as each operator pays careful attention not to skip a code or place an improper number on the line.

Wheels travel off the flat belt conveyor to an elevated section of belt conveyor that delivers them at a height of approximately six feet to a section of gravity roller conveyor. An escapement mechanism at the lower end of this conveyor feeds wheels one at a time to the valve assembly machine. This escapement causes those wheels that have accumulated behind it to be in contact regardless of the spacing interval at which they were originally placed on the flat belt. When a sufficient number of wheels have accumulated on this gravity roller conveyor to cause the interlock switch at the top to be held depressed the belt conveyors that feed this section shut down.

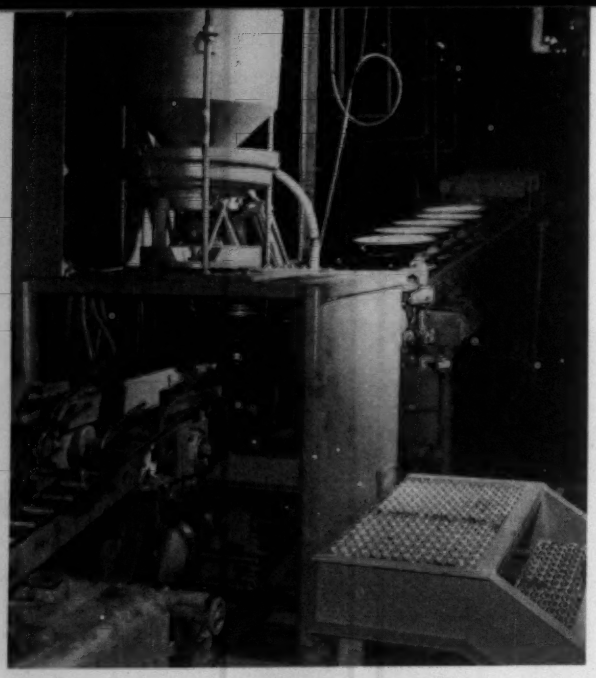


Fig. 4—Exit side of the valve inserting machine is shown. Vibratory feeder on top of unit keeps loader supplied with valves. After receiving valve stem, wheels travel through to gravity roller section at left which takes them to the rim loader station on the mounting machine conveyor.

Valve Inserting

As a limit switch is tripped in the cycle of the valve inserting machine, the escapement mechanism is actuated and causes a wheel to move off of the gravity roller conveyor into the center of the inserting machine, *Fig.* 3. This machine automatically cycles. The wheel is elevated to make contact with a revolving plate in the top of the machine. The wheel rotates until a probe drops into the valve hole. This action causes a brake to be applied to the rotating plate which in turn actuates an air cylinder that pushes a valve through a breechblock loader into its assembled position in the wheel.

Completion of this cycle trips an escapement in the outlet tube of a vibratory feeder mounted on top of this machine and feeds another valve into the breechblock loader. The wheel is lowered to the center of the machine and conveyed out, *Fig.* 4, to a device called a rim loader that positions the wheel in such a manner that the hole in the center of the wheel will be engaged by a driving peg fastened to a plate on a slat conveyor.

Feeding of the valves represents an example of the oft spoken axiom that automated equipment requires high quality workpieces for proper functioning. In the development of the bowl design for the vibratory feeder which delivers valves large-end first to the outlet tube, it was found that valves with excessive rubber mold flash around the largest diameter would not feed properly in the bowl track. The flash acted as a dampener and cancelled out the vibrating effect of the bowl. This situation caused an upgrading of the quality specification of workpieces which when manually assembled to the wheels were acceptable with a greater amount of molding flash.

Mounting Machine

Whereas the equipment thus far described represents a continuous cycling intermittent motion type of action, the slat conveyor of the tire mounting machine is continuously in motion. After each workpiece-station passes the rim loader it moves under a safety gate wired into the control circuit which assures that each wheel is seated properly on a driving peg. The wheel is cause to rotate by rolling contact with a soaping pad, *Fig.* 5, mounted at the side of the conveyor. The contour of this pad is such that liquid soap is applied to the entire periphery of the wheel. This soaping operation provides lubrication that allows the tire to move easily onto the edge of the wheel rim during the inflating operation.

Above the center of the mounting machine conveyor is an escapement which is the termination of the tire supply branch line. Details of this branch are similar to those of the wheel line that was previously described, except that the elevating belt conveyor attains a height of 87 inches where it feeds into the curved gravity roller section. This height difference is necessary to provide space for the tires, which are of greater diameter than the wheels, to be rolled down a curved gravity roller section that delivers them to the mounting machine conveyor in an almost vertical position.

Cam plates welded to the slats of the conveyor at each workpiece station move limit switches that actuate this escapement mechanism at such a time that the tire is dropped between a stop bracket and the wheel and assumes an inclined

Fig. 5—Wheels are shown feeding from the left from a gravity roll section through the rim loader escapement that loads them one at a time onto the driving pegs of the fixture stations on a slat conveyor. On the far side of the conveyor is a device which rotates and soaps the wheels as they pass. This facilitates tire mounting and inflation.

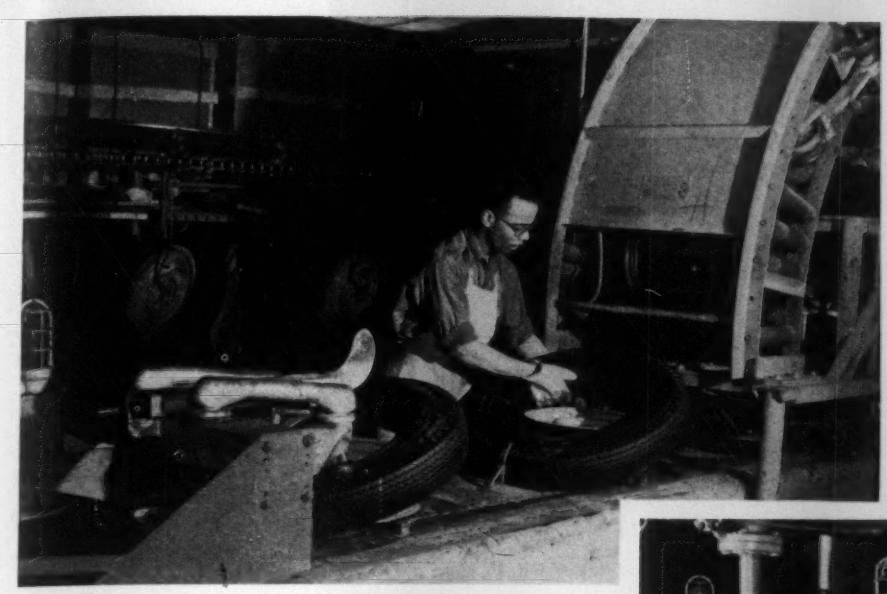


Fig. 6—Tires are dropped automatically into position over the wheel by means of a limit switch operated escapement. Operator is lining up the valve with a balance mark on the tire. Wheels move to the left under the device that mounts the tire to the wheel.

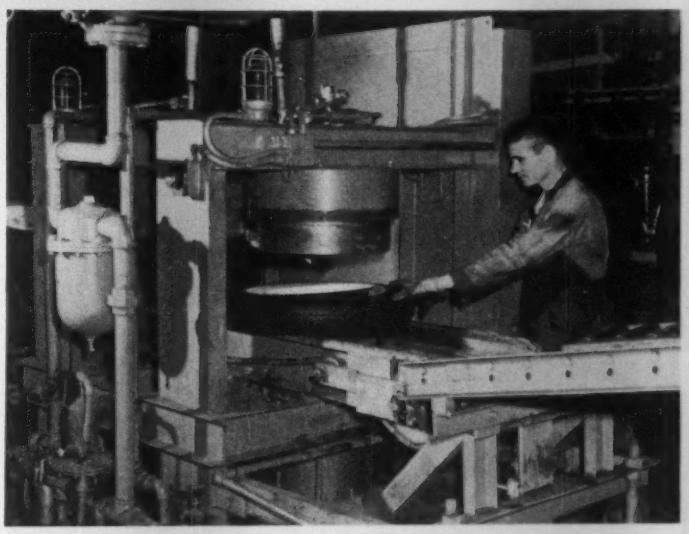


Fig. 7—From the tire mounting device the tire and wheel assembly moves into an automatic tire inflator. Assembly line was engineered by Airway Products engineers working with Ford Motor manufacturing engineers.

position over the edge of the wheel. An operator at this station of the machine rotates the tire and/or wheel so that a balance mark on the light side of the tire is lined up with the valve, which is the heavy side of the wheel, *Fig.* 6.

Wheel and tire continue to be moved along by their peg on the slat conveyor and are taken under the automatic mounting head. Certainly the least maintenance difficulties can be expected from the automated equipment that is the simplest in design. This head represents an achievement in simplicity for it is able to automatically put the tire around the wheel without the use of electrical, hydraulic or pneumatic controls or actuators.

The mechanism involves two horizontal arms that are pivoted from a bridge assembly that spans the conveyor. On the extremity of each of these arms is mounted a cam follower roller and plow shaped guide surface. As the tire and wheel approach the bridge a third fixed center arm assures that the first side of the tire is below the arms, then the rollers each contact the approaching edge of the wheel rim and its curved surface causes the followers to move the arms outward and the guide surfaces iron the tire bead down over the rim. As the tire passes under the bridge the center arm assures that the back side of the tire has popped over the rim and the pivoted arms are returned to their center position by spring action. The mechanism is thus reset ready to mount the next tire over the approaching wheel.

Should an arm detail or spring break, the Ford production department has a spare bridge assembly ready to mount and production can quickly be resumed. As future production requirements dictate that this line accommodate more than one thickness of wheels the bridge assembly will be provided with a height adjustment and be ready for the new production runs.

▶ Tire Inflating

Processing engineers must be ever alert to opportunities to improve production techniques. One area that is constantly watched is the product design. When a change is made in the product an opportunity may be presented to devise a new processing technique that can provide real savings in manufacturing costs. Such is the case with tire inflation operations. When inner tubes were used it was necessary to apply the air ressure to the valve. There was no other way to get the air inside. Upon changing to tubeless type tires it was found that the air could be applied around the entire periphery of the rim and thereby eliminate time-consuming inflation through the valve.

As assembled tires and wheels come off the end of the tire mounting machine conveyor they are elevated by a transfer conveyor and deposited on another section of gravity roller conveyor, the lower end of which feeds a tire inflating machine.

Transfer conveying within this machine is of the intermittent motion type. The assembly stops beneath an inflating head, *Fig.* 7. Limit switch

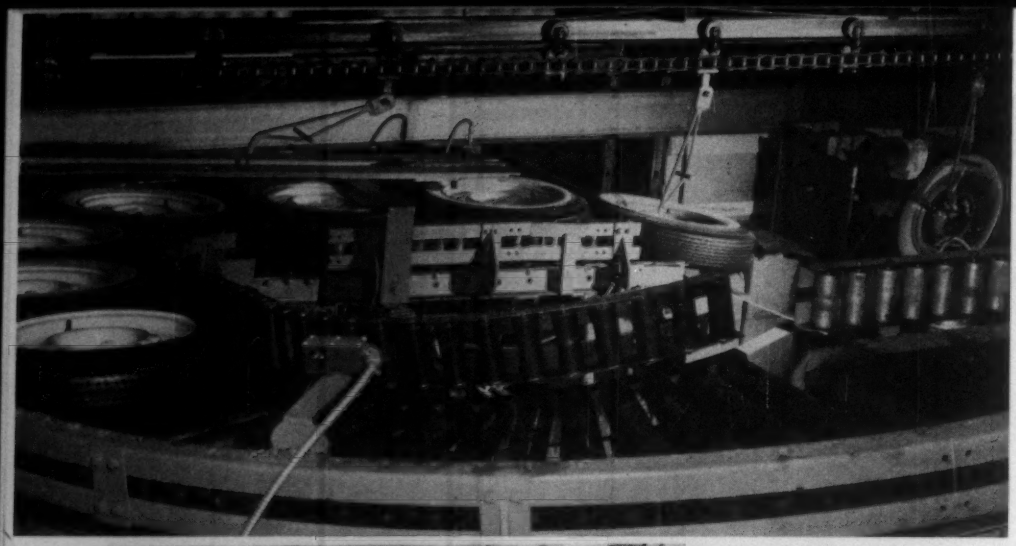


Fig. 8—After inflation the wheels are fed to a conveyor loading station where trolley hooks are dropped into the wheel hub hole by means of a cam track.

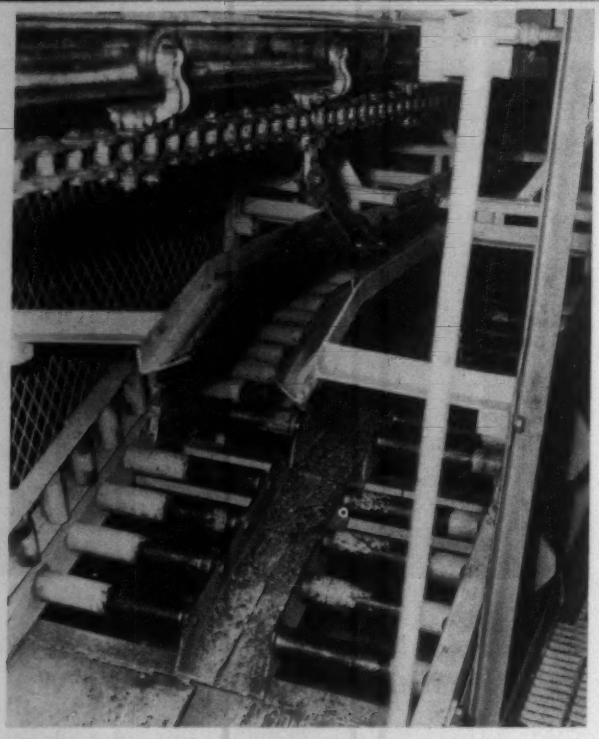


Fig. 9—Inflated wheel assemblies travel in the proper sequence from the subassembly area to the final assembly line and are automatically unloaded by means of cam tracks that engage the crossbars and elevate the hooks out of the wheels.

contact trips an actuator that raises a feed stop pin and prevents another tire from entering the inflation area before completion of the cycle. The cylinder below raises the wheel and tire platform to such a height that contact is made with concentric rings on the inflating head. Sealing on the rim is accomplished by the inside ring and sealing on the tire surface by the outside ring. Relative heights of the rings are such that the tire is held below the upper edge of the rim. This arrangement creates an air chamber whose two parts are the annular space between the inflating head rings and the tire and wheel cavity. Air pressure is applied to this chamber. When the proper inflation value is reached the supply is cut off and the tire assembly lowered away from the inflating head. Air pressure within the tire forces it against the rim surface, sealing it against leakage.

This method of inflation can be accomplished in a small fraction of the time formerly required to inflate a tire through the valve. The machine used in this installation is of the double-station, tandem type in which either or both stations can be made operative, depending on production requirements.

Transport Away

These wheels are now ready to be assembled to the automobile. The inflated assembly is lowered onto the machine's chain conveyor that delivers it to an elevating belt conveyor that feeds a *U*-shaped section of gravity roller conveyor. The end station of this section is an automatic pickup point on a trolley conveyor line, *Fig.* 8, that transports the wheels to the final assembly line. Like all of the other sections of gravity roller conveyors in this system there is an interlock switch at the top of this section that shuts down the inflating machine if tires accumulate back to this point.

Hooks on the trolley conveyor are deflected by a cam track that lifts each in turn to a position above the next waiting wheel. The hook drops off the track and into the hole in the center of the wheel, pulling it off the end of this station and allowing the next wheel to be fed by double escapement feeder into the pickup position. In normal operation the trolley conveyor is continually in motion.

Final Assembly

Approach to the final assembly line is made overhead at right angles to the travel of the line. Since wheels are manually assembled to the cars it is desirable to drop them on each side of the line. Wheels are delivered to chutes beside the line such that for any given car there are two on

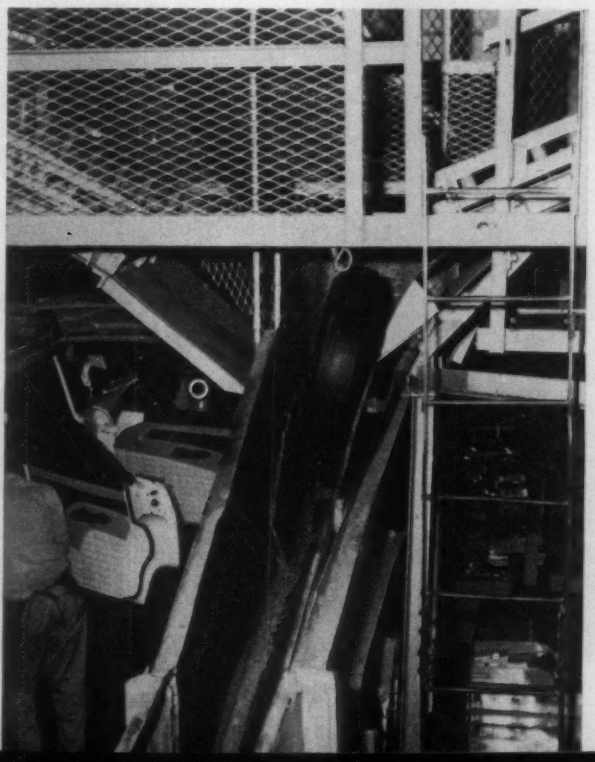
one side and three on the other. For the next car in line the three and two sides are reversed. This system balances the work load for the two operators working the opposite sides of the line, so that each puts the spare tire into every other car.

Here again simplicity of control is desirable and the necessary delivery pattern is accomplished by use of alternate long and short crossbar members welded to every other trolley hook. As the wheels approach the final line they are laid back into a horizontal position by coming upon a section of roller conveyor. The hooks continue to pull the wheel along this section, *Fig.* 9. Long crossbars on every other hook engage a cam track surface and pull those hooks out of the holes in their wheels. These wheels move free of the hook on descending gravity rollers and drop into the chute on the approach side of the line, *Fig.* 10.

Hooks with short crossbars do not engage the cam tracks which are spaced too far apart to permit this. These hooks remain in the wheels and carry them through this unload section to a similar unload section on the opposite side of the final line. Here the cam tracks are closer together so that all hooks are caused to be elevated. Thus the remaining tires are dropped free into the chute.

Assembly men on the final line pull each tire in turn from the chute, *Fig.* 11, and have no selection problem because the right tires and wheels have been moving to this point in timed sequence since they were loaded to the flat belt conveyors in the wheel assembly department. If the final assembly operations are shutdown or delayed the wheels will accumulate in the chutes to such a height that an interlock control will shut down the trolley conveyor. This action will cause a progressive series of such actions at each of the interlock points back up the wheel line until finally the belt conveyors in the wheel and tire storage areas are shutdown. Under these conditions all accumulation sections are filled and when assembly resumes each work station in turn starts again without having to wait for material.

Fig. 10—View shows an unloaded wheel assembly falling into the chute that feeds one side of the final assembly line. Every other wheel crosses over this point and is unloaded into a similar arrangement on the other side of the line.



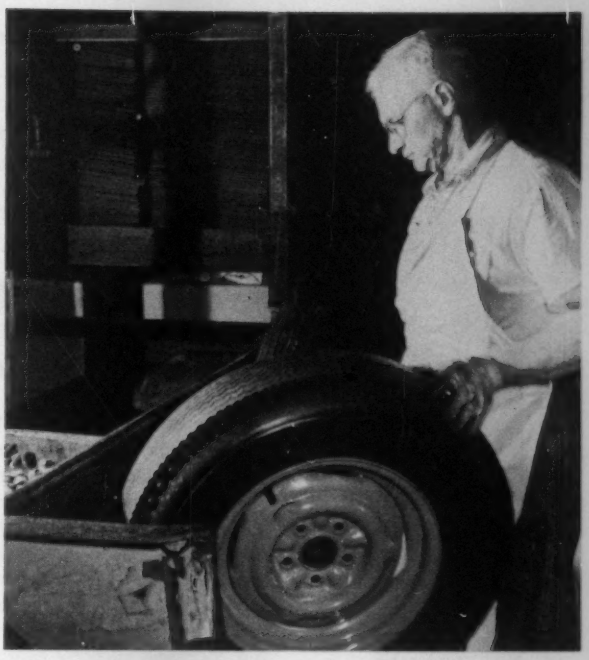
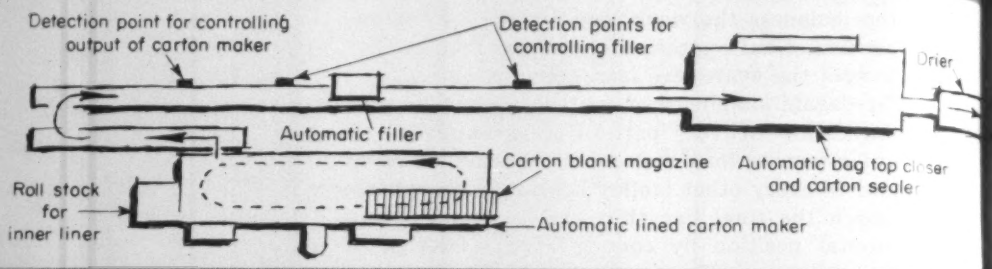


Fig. 11—Operators who install the wheel assemblies to the car remove each in proper sequence from the chute ends at their work stations on each side of the final assembly line.

Highly Automated

This subassembly line that is tied directly with the final assembly line represents a high degree of automation. Appropriate use of escapements and feeders has enabled automatic transfer from intermittent to continuous motion and back again as best suits the type of operation being accomplished. All transfers from one type of conveyor to another are accomplished without manual assistance. Functions are electrically interlocked so that the complete installation can be said to function as one automatic cycling machine.

Further processing refinements that can be envisioned include automatic balancing equipment for the assembled wheel and tire and automatic assembly of the wheels to the car. Certainly as new design improvements in wheels and tires are introduced into production runs the manufacturing engineers and their equipment suppliers will get even greater challenges for automated lines that give the customer high quality cars at competitive prices.


Detection point for controlling output of carton maker
Detection points for controlling filler
Drier
Automatic filler
Carton blank magazine
Automatic bag top closer and carton sealer
Roll stock for inner liner
Automatic lined carton maker

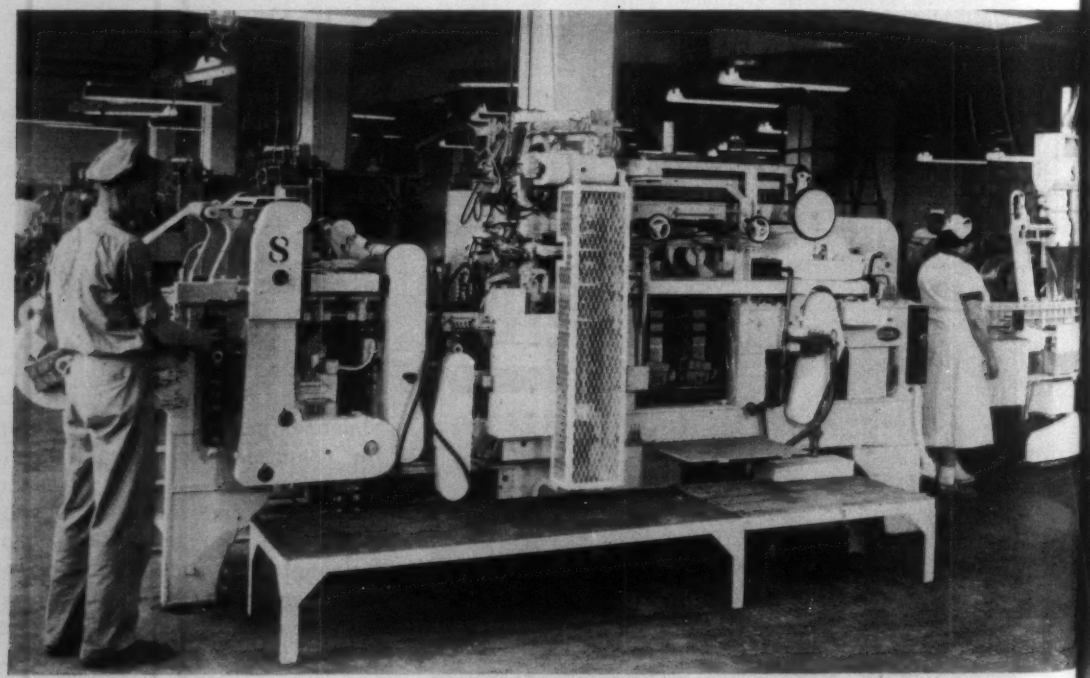
1 Flow chart for automated food packaging line. Filler is only unit that needs detection devices ahead of and beyond its operating point. Detection device ahead of the filler prevents its dumping a load on the conveyor and floor when no cartons are present under the filling heads. All other machines are stopped by detection devices only when conveyors between them are in danger of becoming overfilled due to stoppage of the machine directly beyond them.

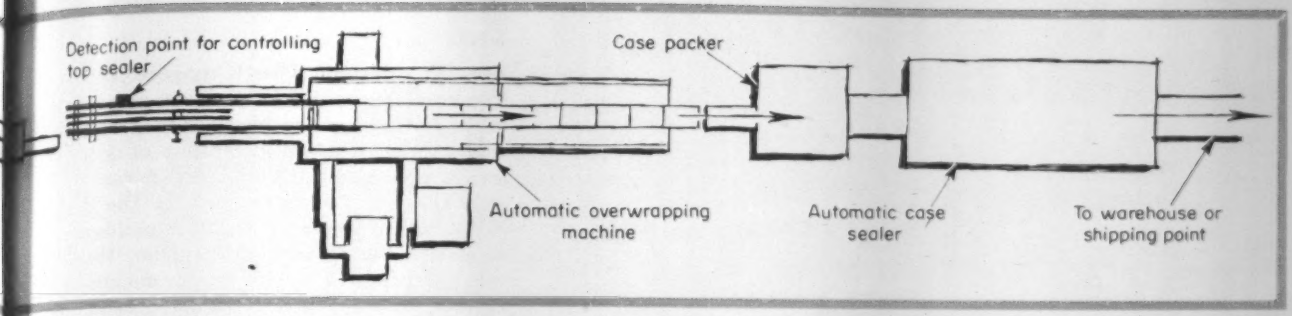
AUTOMATION TODAY

By KEITH H. REDNER
Vice President
Battle Creek Packaging Machines, Inc.
Battle Creek, Mich.

2

Cereal packaging line begins with this machine that makes the inner bag or liner, and a carton around the liner. Machine feeds the liner paper from the roll shown at the left, forms and heat seals the cut sheet around an aluminum forming block or mandrel, applies glue to the carton flaps, and puts pressure against the bottom flaps to set the glue preparatory to removing the lined and bottom-sealed carton from the machine. Services of operator at left are required when machine needs liner or carton stock. Inspector at right maintains vigilance over quality of the entire line's output.





PACKAGING

DRY FOOD PRODUCTS

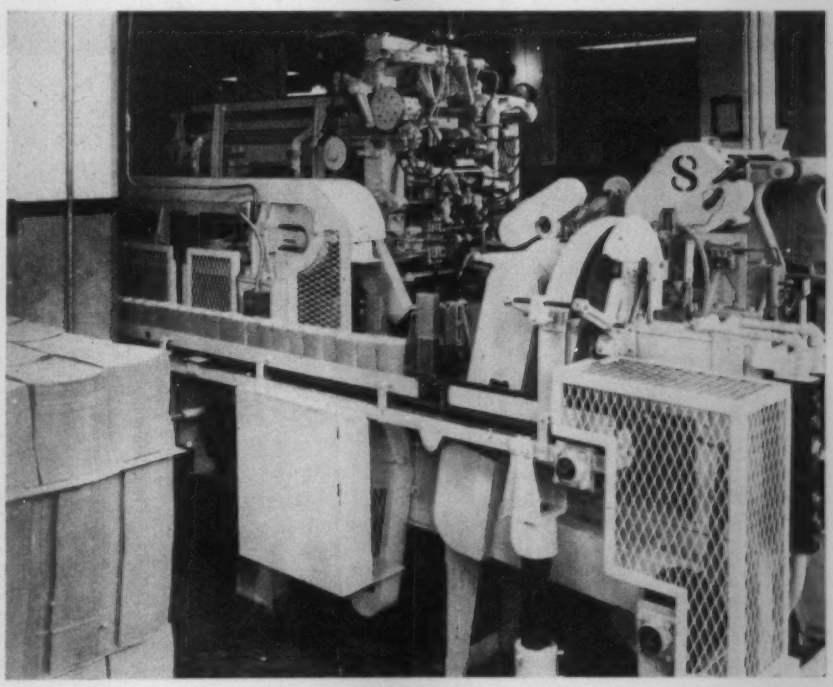
PREPARED DRY food products such as cake mixes, sugar, flour, dried fruits, baby foods, cereals and the like are packaged in individual cartons for consumer sales. A typical package consists of an inner bag (of waxed paper, glassine, or foil) a carton formed around this liner with glued flaps on side, top and bottom; and a printed overwrap to describe the contents, give the packaged goods added protection, and provide eye appeal to inspire sales.

Processed products packaged in this type of container are usually made on a continuous flow basis. The packaging line must keep pace with the processing line and operate dependably without interruption so as not to cause shutdowns that back up the flow of material. Wastes in such instances include possible product spoilage and lost production time.

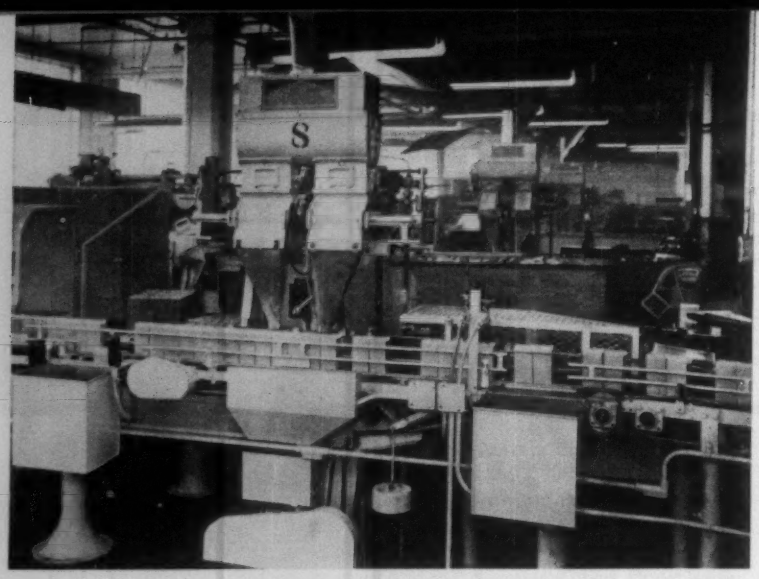
Fully automated packaging line, featuring automatic controls throughout, and intermittently requiring the services of an operator is illustrated by the accompanying photos taken in a plant manufacturing breakfast foods. Equipment shown is made by Battle Creek Packaging Machines, Inc. and is capable of speeds up to 120 packages a minute.

Synchronizing and control circuitry is arranged to co-ordinate the operations of each machine with

3



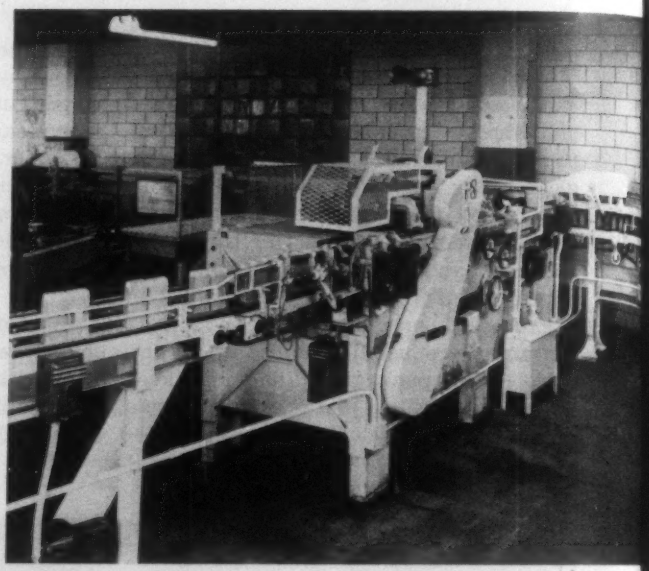
This is a rear view of the automatic lined carton maker shown in *Fig.* 2. Palletized stacks of die-cut cartons are ready to be loaded into the magazine feeder on top of the machine. These flat sheets set on edge in the feeder and move across horizontally to the end position from which they are fed into the machine. Machine has built-in controls to automatically clean itself and sound alarm when either roll stock or carton blank supply is exhausted. Lined and bottom-sealed cartons are discharged to a conveyor which in turn carries them to a filling machine.



4

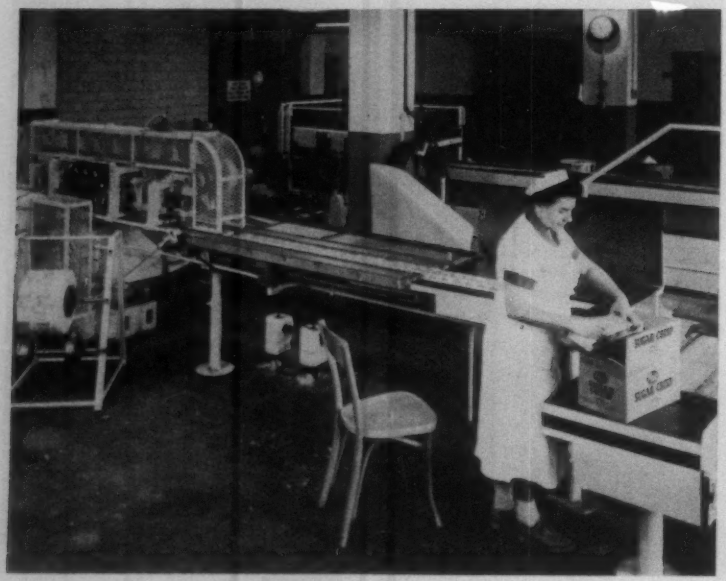
Two-unit volumetric filler is supplied with free-flowing cereal from ductwork above. In the left part of the photo at the point where there is a gap in the line of cartons is a photoelectric device that automatically ejects a carton from the line if it has fallen over and is not in position to receive the contents at the filler. The solenoid actuated ejector knocks the carton into the receptacle in the foreground. A similar arrangement shown to the right of the filler ejects cartons that are underfilled. This low-level detector has an oscillating mechanism that reaches into each package and closes switches in the circuit of the eject device if the height of the contents is below the assigned level. Acceptable packages are conveyed on to the top-sealing machine.

the adjacent machines. These functions include shutting off the filling machine when no carton is in place, automatically stopping the carton maker when the filling machine runs out of material, checks for overturned and underfilled cartons, and switches such that if any machine is stopped for any reason the machine preceding it will be automatically shut down.



5

Filled packages automatically enter a packaging machine that folds over the open mouth of the liner, applies heat to the liner for closing the packages, applies glue to the top flaps and folds and seals the top flaps of the carton. Control circuits of this machine synchronize its various operations with the other equipment in the event the supply of filled packages is interrupted or out of balance. Going off the picture to the right is a compression belt line that holds the package under pressure during the time the glue on the top flaps is setting. Equipment has Lincoln Engineering automatic lubrication system.



6

Overwrapping machine at the left uses photoelectric control to scan roll stock for registration marks. This control synchronizes the sheet cutoff mechanism. Automatic paper trips allow this equipment to operate only when a package is in position for wrapping. Machine discharges to cooling unit that allows immediate packing of heat sealed packages into shipping cases. Machines shown in these pictures are built by Battle Creek Packaging Machines Inc. Operator packs cases which are transported by conveyor to case sealing machine.

SYNCHRONIZING SENSING AND PROCESSING

By A. S. BURGOYNE
Pratt & Whitney Co. Inc.
West Hartford, Conn.

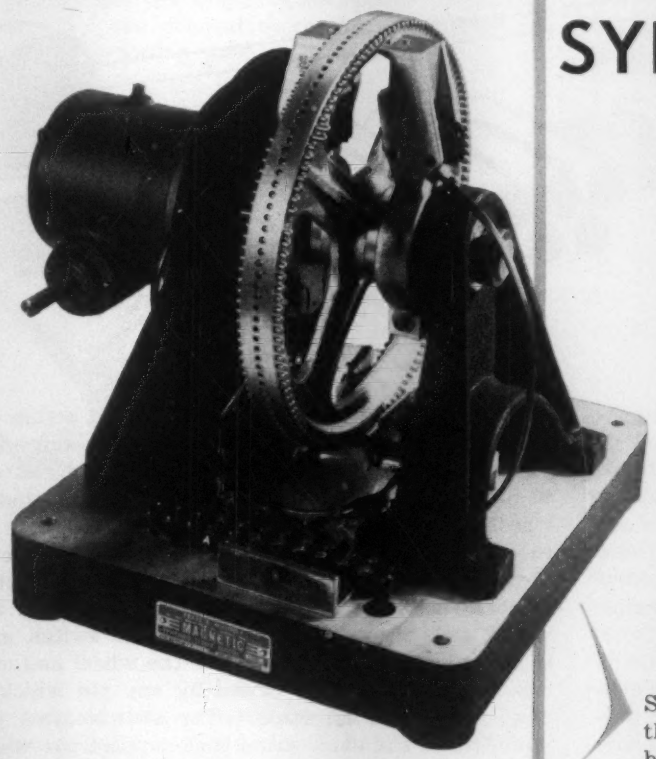


Fig. 1—Timing wheel in this two-position information co-ordinator is driven mechanicallly by the associated process line. Pins through the rim of the wheel are displaced by positioning devices and actuate sensitive switches when the wheel rotates a predetermined distance.

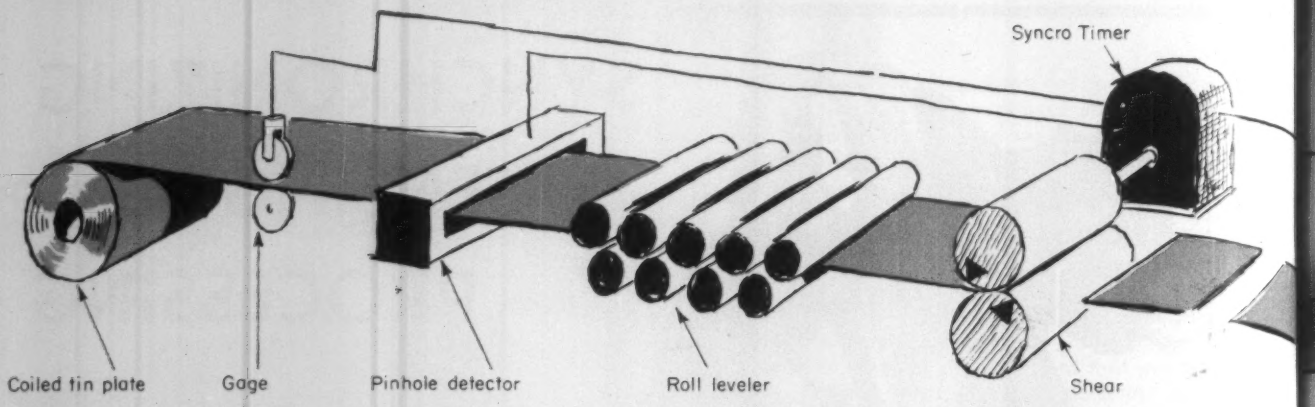
Actions or information on a continuous processing line must often be based on information about the product which was obtained at an earlier point on the line. Electromechanical devices have been developed to automatically synchronize the delay of information with progress of the material. These units act as intermediate components to temporarily store information between input devices and control units or data comparators.

SOLUTIONS to many problems evolve through the application of one or more combinations of simple available components. One specific area in which this occurs is in the coordination of information and actions which are separated by a time interval. Applications of synchronized information delay devices are many and varied and are not confined to any particular industry or process. Basically they apply where there are problems requiring control actions or information based on previous information. The most straightforward way of explaining application possibilities with such equipment is to describe some units and specific jobs to which they have been applied.

Two Basic Types

Two basic types of information delay devices are manufactured by Pratt & Whitney Co. Inc. First developed was the Syncro Timer, a device which temporarily stores information that can be recorded on a two-position basis such as *On* or *Off*, *Yes* or *No*, *Either-Or*, etc. An outgrowth of this device is the Proportional Syncronizer which stores the magnitude of a variable and reproduces that information at a later time in synchronization with the speed of the processing line.

Both types are based on the use of a timing wheel which is rotated about its axis at a speed proportional to process speed or the rate of travel of the material being controlled. The units are self-contained and driven directly from process mechanisms so that acceleration, deceleration, or even stopping does not affect the accuracy of their performance. Around the periphery of the timing wheel and parallel to its axis are holes which carry movable pins. Each pin is held in place in its hole



by means of a spring and ball which permit movement of the pin yet provide sufficient friction to hold the pin in positions to which it is moved.

With the timing wheel mounted to rotate about a horizontal axis, pin positioning mechanisms are usually located at the 6 o'clock position. These mechanisms move the pins in accordance with directions from an operator or readings from sensing devices. As the wheel rotates, each pin goes from the positioning station to a reading station. Ratio of wheel speed to process speed and angular displacement of the reading station from the positioning station are arranged so that the pin arrives at the reading station when the material it describes reaches a certain point. The main difference between the two types of delay devices lies in the positioning and reading mechanisms. The two-position devices use a switch for reading pin position and are either operated or not operated. The relative value units employ a pickup head which senses the relative position of the pin. After passing the reading station in either type, the pins continue their circular path and are pushed back to normal or mean position by a centralizing cam.

▶ Two-Position Memory

Two-position storage units such as the Syncro Timers, *Fig.* 1, are applied where there is a problem of material handling, sorting, or classifying. They function as remote control delayed action relays for controlling distribution on a conveying line or sorting mechanism in synchronized relation to the movement of the processing line. The timing wheel is supported by two arms from the base of the unit, and a solenoid is mounted at each side of the wheel. These solenoids are the positioning mechanisms, and with one on each side of the wheel, two circuits are available. A switch arm is also mounted at each side of the wheel and carries a switch which is closed by any pin which is displaced in its direction. The switch arms are mounted on the same arms that support the wheel and are adjustable through an arc of approximately 330 degrees.

In operation, a circuit can be closed automatically by a gage or a process occurrence, or manually by means of a pushbutton. When the circuit is closed, the electric solenoid for that circuit is energized and pushes a pin out of normal position in the timing wheel. As the timing wheel revolves, the offset pin moves to the reading station. There it actuates the switch carried by the switch arm on the opposite side of the wheel from the solenoid which displaced the pin. When the switch is closed, the circuit of the operating or sorting mechanism is completed. As the timing wheel continues to rotate, the offset pin passes through a centralizing cam which restores the pin to its normal position in the wheel.

The two circuits available on each timing wheel

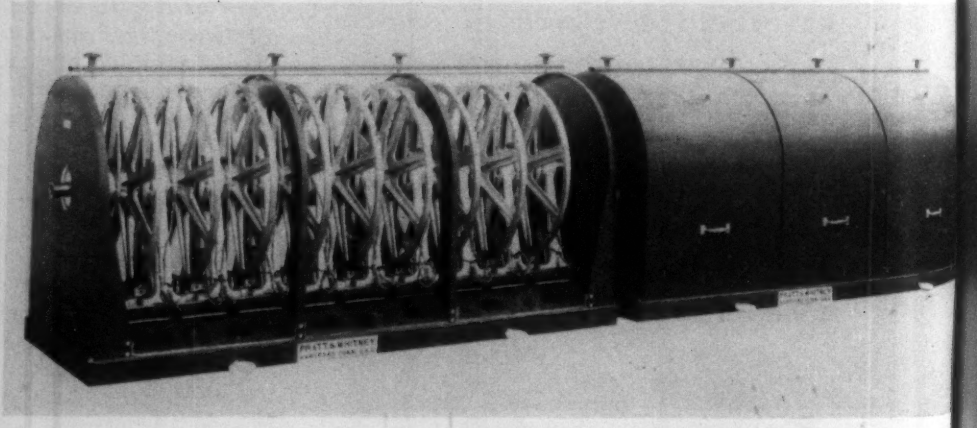
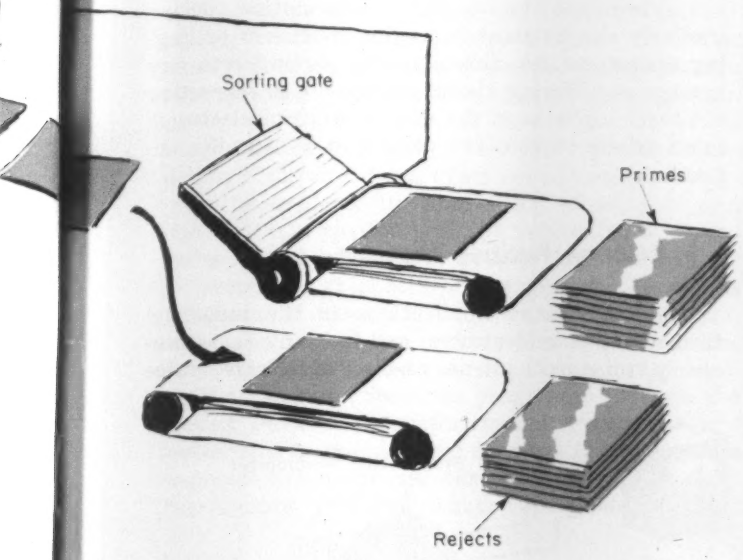


Fig. 3—Since each timing wheel may be used to control two circuits, this special 18 wheel unit can control 36 circuits. In the handling installation for which it was designed, oil drums traveling on a main conveyor can be selectively shunted to any of 36 lateral conveyors or loading platforms.

Fig. 2—Diagram of the tin-plate shearing line for which the Syncro Timer was originally developed. Gage and pinhole data are delayed to control classification of sheets at the sorting gate.



may be used independently or can be used in tandem to provide a single circuit having, in effect, twice as many pins. This method permits greater accuracy where space limitations and cost dictate the use of a small wheel.

When the unit is used on a conveyor line with push bars or other means of positively positioning the article being transported, the timing wheel is designed so that each pin represents a conveyor push bar. In this manner very accurate positive timing is accomplished. When the Syncro Timer is used with a conveyor where the parts are placed at random without positive positioning, special formulas give the size of timing wheel to be used, the proper gear reduction, and the accuracy obtainable.

▸ Applying Two-position Delay

The application which brought about the original development of the Syncro Timer was in connection with tin-plate shearing lines in the steel industry. In this operation, *Fig.* 2, strip steel is fed through a continuous gage, a pinhole detector, roll levelers, and then through a shear where it is cut into sheets. The problem was to gage the steel while in a continuous form and sort it some 35 feet away after it had been cut into sheets.

Driven from the shear, the Syncro Timer is synchronized with the speed of the strip passing through. The continuous gage and the pinhole detector which notes slight pinholes in the strip feed a signal automatically into the Syncro Timer when an off-gage section of the strip has passed through or when a pinhole has been detected. Either signal operates the solenoid which displaces a pin. The pin travels around the wheel to the switch arm in the same interval that the strip passes through the shear and thus "times" a sheet to the sorting gate. In many instances the speed of this line is upward of 1000 feet per minute and yet accurate sorting of off-gage or pinholed sheets is accomplished. The size of the timer which is employed in the particular operation is dependent upon the distance between the gaging element and the sorting or dispatching gate. In some installations such as on an electrolytic tinning line which not only cuts the sheets but also performs a continuous electrolytic tinning operation before shearing, the distance between the gage and the sorting gate is around 200 to 300 feet. In this instance, the largest timing wheel, having 248 pins, is employed.

For this particular shearing application the Syncro Timer has externally adjustable switch arms with a dial equivalent to the setting, calibrated in sheet length. This becomes necessary when the length of cut is varied over a wide range to insure the classification of the particular sheet which was gaged in strip form.

In a large refinery on the West Coast which was being completely mechanized so far as material handling, shipping, and distribution were concerned, it became apparent that there was the need for a memory device to make the system workable. Involved is distribution of 55-gallon oil drums from a warehouse to 36 different freight loading

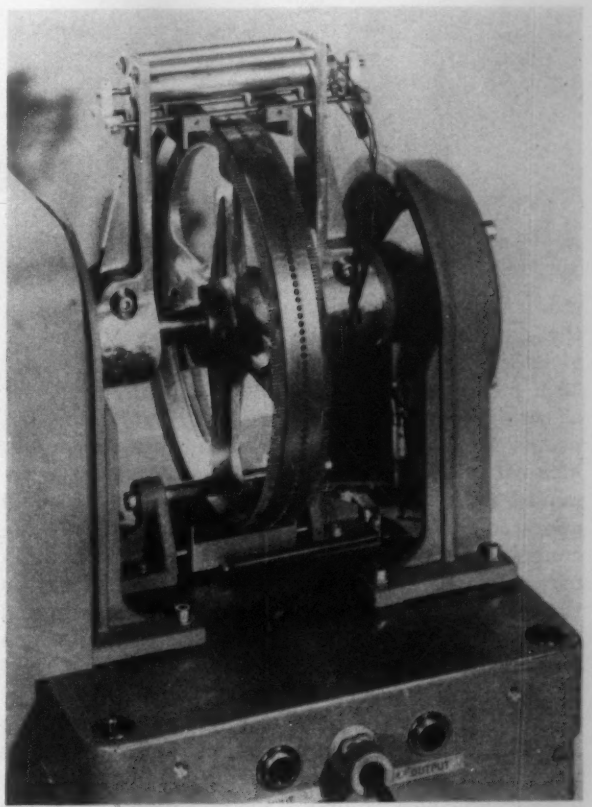


Fig. 4—Co-ordinated delay of relative values is possible with this unit. Developed from the two-position unit, it uses a similar timing wheel, but amount of displacement of the pins is varied to store relative quantities.

platforms or cars. In the warehouse the drums are loaded on a conveyor traveling at 100 feet per minute. With proper color coding or significant marking, the distribution operator can select the proper distribution point as the drum passes his control board station. The control panel consists of 36 pushbuttons, each representing a lateral or a loading platform. Each lateral is also represented by one circuit on a timing wheel in a special 18-wheel unit, *Fig.* 3. This installation enables one man to sort and distribute 55-gallon oil drums at the rate of one every 3 seconds.

A unique application in an entirely different industry is represented by the use of a Syncro Timer in a sawmill for the sorting and distributing of logs, as they are conveyed from a river or first storage area to graded storage areas according to the kind of wood, such as spruce, pine, fir, cedar, etc. An operator is located at the entry end of the conveyor where the logs are loaded, and he visually determines the type of wood. By means of a pushbutton he sets up the Syncro Timer for shunting the logs off the main conveyor into their proper location. When the log reaches the proper kick-off station the conveyor stops, the log is removed from the conveyor by an electric solenoid operated hydraulic ram. As the log falls off the conveyor, it actuates a limit switch which automatically resets the solenoid circuit and starts up the conveyor. One operator can segregate and automatically sort logs in a sawmill operation which previously required from four to five men and operated on a much slower cycle.

In the leather industry, the Syncro Timer is also applied to a sorting application. Here the hides pass through an area measuring machine and the area of the hide is indicated on a dial. After the hide is measured it passes through a washing and drying machine, and then comes to the dispatcher whose job it is to remove it from the conveyor. The operator at the area measuring machine, some 50 feet from the dispatcher, classifies the hides into four categories based on the area reading. He enters the classification of a hide on a two-wheel Syncro Timer and the dispatcher receives the proper signal when that hide arrives at his station.

Synchronized two-position information delays similarly can be used in gaging machines or gaging operations for automatically sorting into any number of different classifications, or on inspection machines, such as in the manufacture of electronic tubes where rejects are separated by specific defects.

▶ Relative Position Memory

There are many applications in the industrial field where it is desirable, and in many cases necessary, to store a meter reading or relative value for use at some later time in the process. Storage of readings may be required to obtain the difference between two meter readings on the same portion of a material at different steps in its processing. Such delay may also be required to obtain a meter reading before an operation occurs and release the metered information for control purposes as the action occurs.

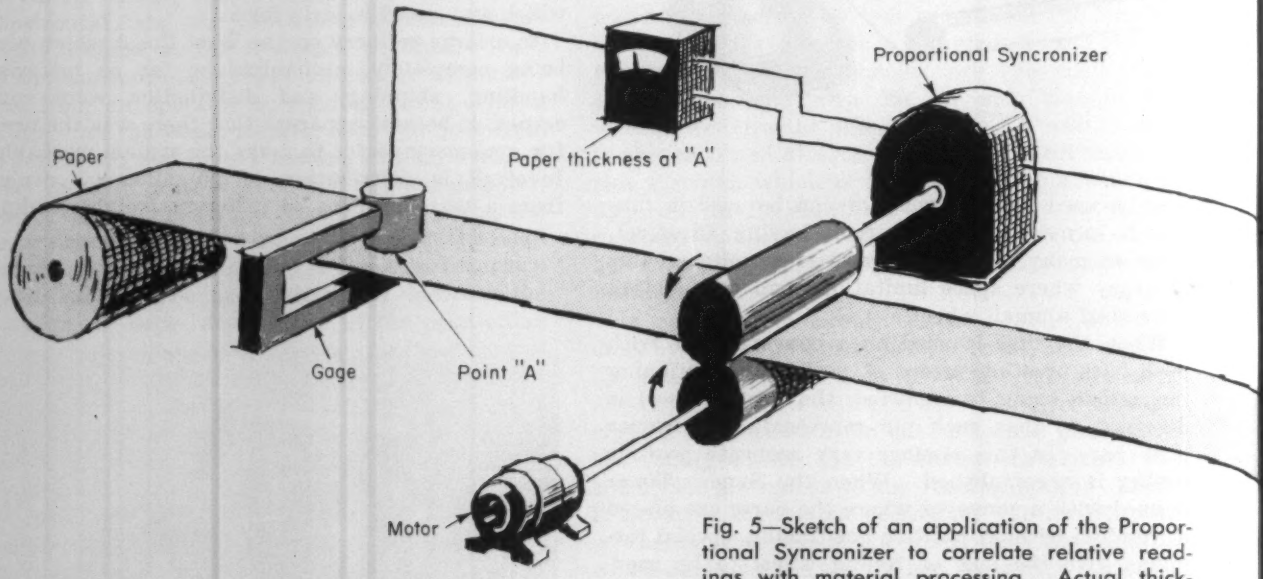


Fig. 5—Sketch of an application of the Proportional Syncronizer to correlate relative readings with material processing. Actual thickness of coating alone is obtained.

Pratt & Whitney's Proportional Syncronizer, *Fig.* 4, is a device for co-ordinated delay of such relative readings. In the base of the unit is a servomechanism such as is found in a potentiometric recorder. Signals for the servomechanism are supplied by sources just as for indicating meters. When indicating meters are also used, the units are connected in parallel. The servomotor drives a wedge mechanism which displaces the pins in the timing wheel by an amount in direct proportion to the signal input, and in a related direction.

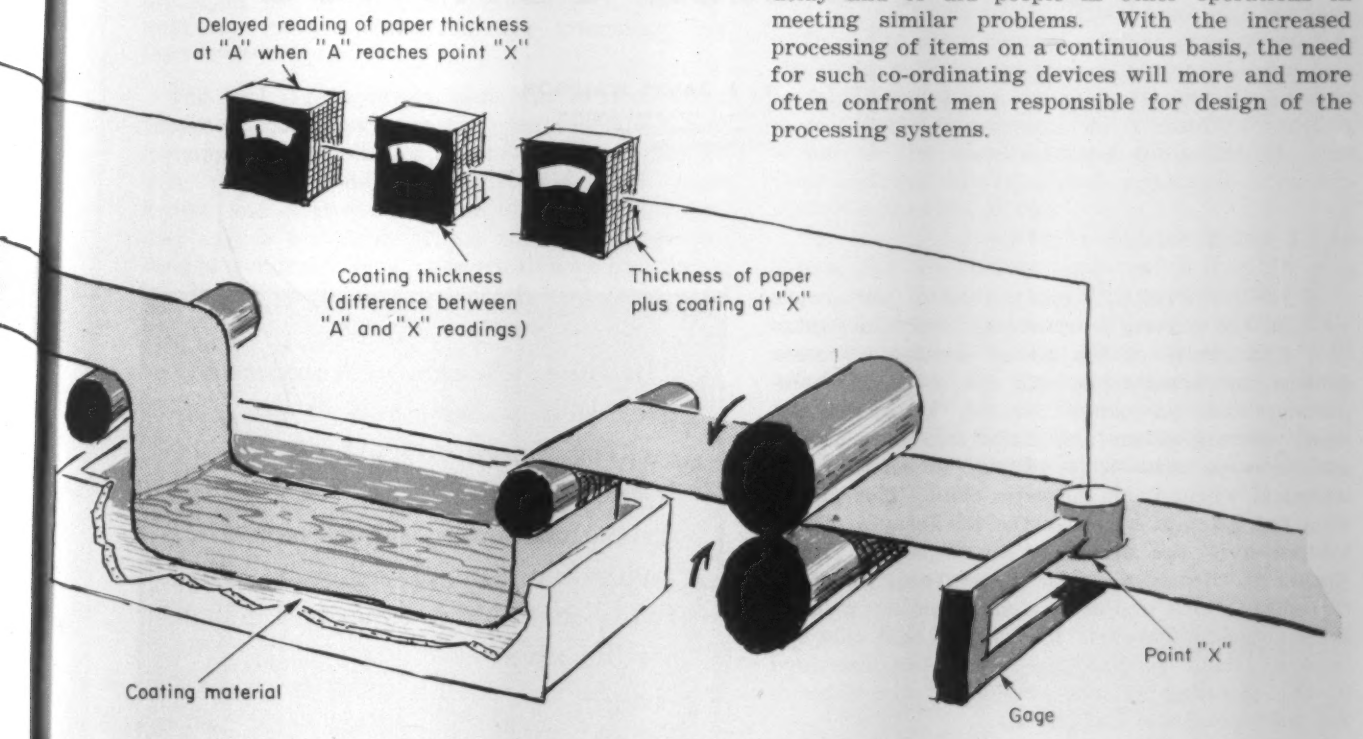
A single pickup head is mounted on adjustable arms similar to the switch arms on the Syncro

Timer. The head is a measuring unit of the ac bridge type, and it measures the displacement of the pins as positioned by the servomotor and wedge mechanism. As in the two-position devices, the timing wheel is driven by linkage to the process so that a pin on the wheel moves from the positioning wedge to the pickup head in the same time that material being processed moves from a first sensing position to a second position. Accuracy of the Proportional Syncronizer is within 1 per cent of full scale, and the repeatability is within 1 per cent for a given set of conditions.

One example of the application of delay of proportional information is in the processing of coated materials where it is desired to know accurately the weight or thickness of the coating. A gage is employed to measure the base material continuously, *Fig.* 5, and the varying dimensional reading from this gage is fed into the data storage unit. As the measured material progresses through the coating process, the meter reading progresses proportionally in the memory device. A gage is then employed to measure the base material plus coating. The reading of the first gage, after being delayed in the memory unit, is subtracted from the reading of the second gage. The difference in the two readings is a measure of the coating thickness of that portion of the material. Even though the base material may vary from portion to portion by amounts greater than the coating thickness, an accurate measure of the coating thickness is obtained.

Another application of the storage of proportional data is in the control of a welding process (See—AUTOMATION, July 1956). Steel strip of varying thickness is being formed into tubing and seam welded. The welding current must be varied in accordance with the thickness of the strip. If the current were held constant, and the material became thicker, a weak weld would result; and if the material became thinner, the seam would be burned. Since it is impractical to measure the thickness of the material at the point of welding, it is done before forming into a tube. The memory unit stores the information on thickness between the time of measurement and the time of welding, and controls the welding current accordingly.

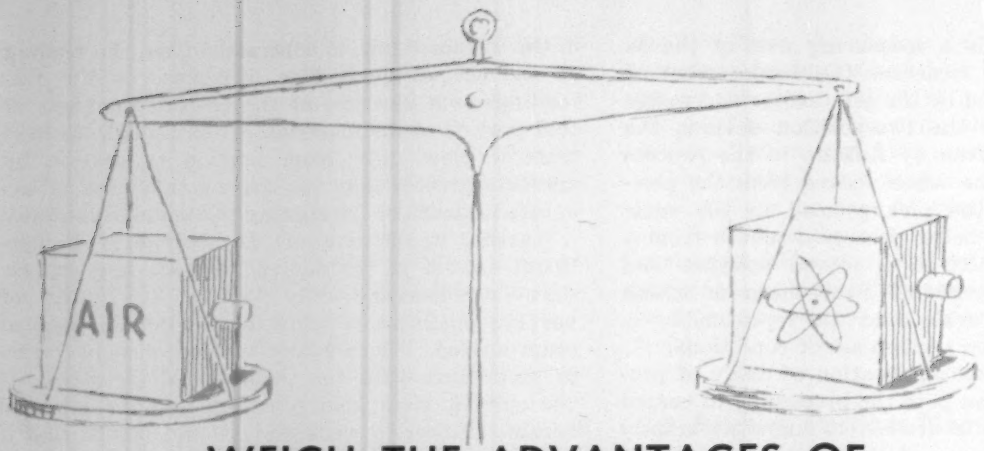
Examples given are not meant to be all inclusive, but rather to illustrate possibilities of information delay and to aid people in other operations in meeting similar problems. With the increased processing of items on a continuous basis, the need for such co-ordinating devices will more and more often confront men responsible for design of the processing systems.


Delayed reading of paper thickness at "A" when "A" reaches point "X"
Coating thickness (difference between "A" and "X" readings)
Thickness of paper plus coating at "X"
Coating material
Point "X"
Gage

What's Your Problem?

DO YOU have a knotty problem in your automatic operations or those you plan to install? Perhaps our experience and knowledge of this field can help establish contacts leading to practical solutions.

To avail our readers of automation information and tap the vast reservoir of practical know-how across industry, the editors have been performing a special service. If, in planning new automation systems, unfamiliar or new requirements present obstacles, write us concerning your needs and we shall be glad to assist in procuring pertinent data on present practices or in ascertaining suitable equipment obtainable from industrial specialists and consultants. We have been able to help in solving many problems, perhaps we can help you in yours.



WEIGH THE ADVANTAGES OF

PNEUMATICS FOR PROCESS CONTROL

By A. JAMES WALDRON
Principal Instrument Engineer
Catalytic Construction Co.
Philadelphia, Pa.

The June 1956 issue of Automation presented a discussion of process control biased toward electronic instrumentation. This article takes up the challenge and presents the pneumatic control argument. Actually, both sides concede a place for the other.

UNDOUBTEDLY many readers are aware of the current controversy over the status and future of the newer electronic process control instrumentation, and the inevitable comparison with pneumatic control. Unfortunately, many misconceptions and distortions have arisen, and in some cases it is difficult to separate the technical wheat from the sales chaff. This article does not attempt to prove the advantages of one system over the other, or to disparage either. Rather it tries to describe the systems, point out their limitations, and make some comments on their salient design features. It is hoped that this will in some small way aid those who are interested in the planning of instrumentation and controls for new processes and plants.

The Background

Process controls, as we know them now, have been in use for the past few decades. Pneumatic controls constitute the majority of present installations; their refinement has been continual for over twenty years. Just before World War II, the so-called full case instrument, shown in *Fig.* 1, reached a high level of development. The control mechanisms are inside the case, along with the primary measuring device or receiver bellows for transmitted signals. As the chemical and petroleum processes increased in size, complexity and cost, two major drawbacks in pneumatic instruments accrued:

1. Processes required more instruments. Consequently, the panel boards grew in size, consuming costly floor space. A conventional panel board is shown in *Fig.* 2.

2. Increase in physical plant size caused serious transmission lags in signals of the pneumatic systems. Maximum transmission distances between a recorder-controller and its transmitter, and to the final control element (usually a control valve) are approximately

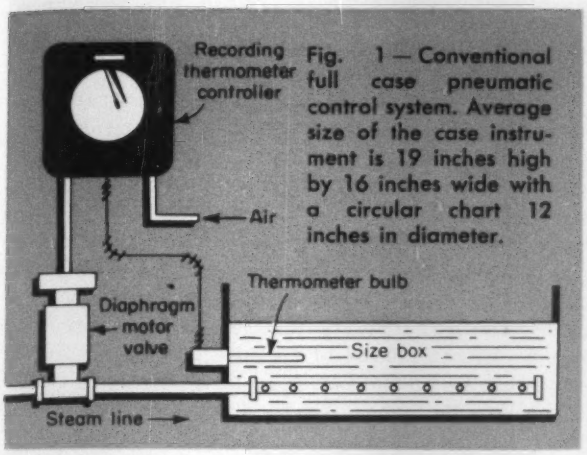


Fig. 1 — Conventional full case pneumatic control system. Average size of the case instrument is 19 inches high by 16 inches wide with a circular chart 12 inches in diameter.

500 feet. Beyond this, it was found that the time interval between a change in the process and the reflected and attenuated change at the controller, plus the additional time for the final element to completely respond to the control signal, was such that the process might not be adequately controlled. A practical limit for the pneumatic full case instrument had been reached.

The next logical development was to remove the control mechanisms from the case and into a new housing. Where linkages and bellows were used to give the functions of proportional band, reset action and derivative action, now spring-loaded diaphragms are used. These small units are arranged vertically in a cylindrical housing, giving rise to the popular name of stacked diaphragm controllers. A physical arrangement of the new pneumatic control loop is shown in *Fig.* 3.

Two decided advantages offset the drawbacks. The new miniaturized recorder case is approximately 5½ by 5½ inches, instead of 19 by 16 inches. Yet the actual chart record remains about the same, approximately 4 inches in width. Note the full case recorder in *Fig.* 1 to illustrate this. Only one-half of the 12 inch chart can be used for immediate recording. The pen sweeps over the right-hand segment. As the chart rotates the other half of the chart comes under the pen. Thus, the chart's left half is storage. Once the chart has made a complete rotation, it must be removed. Outer and inner chart margins are one inch each, reducing the actual graphical width to four inches on a 12-inch chart. In miniaturization, the chart is a traveling strip, with the same 3 or 4 inch graphical width. The pen moves vertically, the chart horizontally under the pen or vice versa. Thus, more data with the same readability is available in the same amount of space, or more important, the panel size is reduced tremendously for the same number of instruments.

Separation of the controller into its own housing permits its location in the field at the site of the primary and final elements in the loop. This greatly reduces tubing transmission lags in the signals, allowing better response and control, and extends the distance between recorder and its transmitter and control valve to a practical limit of 1200 feet, sufficient to cover the newer plant sizes. However, the number of tubing lines is increased from two to four between the control room and the process in the field. Previously, the transmitter sent a signal to the panel-mounted controller via one tube and the control signal emanated from the control room via a second.

The new piping system is depicted in *Fig.* 3. As before, the transmitter sends out a 3 to 15 psig air signal. It tees in the field, going to the field-mounted controller and to the panel-mounted miniature recorder. The set point signal must still originate from the central control room—it is another 3 to 15 psig air signal set by a pilot valve in the recorder. This goes to another diaphragm in the stacked diaphragm controller. Differences

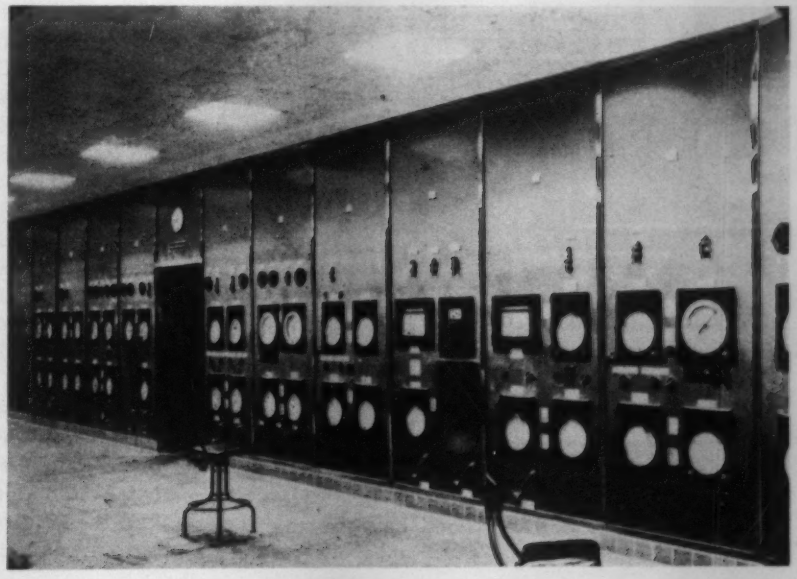


Fig. 2—Conventional panel board using the full case recording and controlling instruments. Any attempt to view more than a few instruments simultaneously is thwarted by the panel size.

in air pressure, representing desired and actual values of the particular variable, are the error detection and correction media. Additions of variable restrictions and capacities in the internal pneumatic circuits provide the functions of proportional band, reset and derivative action. The other two lines allow the operator in the control room to have manual as well as automatic control.

A cutout relay is an integral part of the stacked diaphragm controller, which when actuated by a pressure or venting of pressure (depending on the brand), cuts out the automatic functions and allows a direct air pressure from the pilot valve to stroke the valve. The *Automatic-Manual* selector switch and the pilot pressure regulator are integral within the miniature pneumatic recorder or indicator. When the operator slowly changes this pressure moving the valve, the transmitter sends its signal to the panel instrument, so the operator sees the effect of the valve position. When he reaches the process condition desired for automatic control, he seals in that air output pressure on the valve diaphragm and makes a bumpless transfer to automatic control. The operator knows he is on control by observing a steady state condition, even though what he sees on the recorder or indicator pen may lag the actual condition by several seconds. The control functions are tuned in at the field to give the requisite stability of control.

For the process condition having little or no lags, or if whatever lag there is has no appreciable effect on the control, the control unit may be plugged into the back of the panel-mounted recorder through an adapter manifold. This manifold eliminates the need for the two tube lines of the cutout relay and manual control air pressure, since the manifold has the internal ports necessary for these functions. Thus, we have the advantage of the former two-tube transmission system instead of four tube lines.

However, with the use of miniature instruments, we may in some cases be forced to a four-tube system. Copper tubing, usually ¼ inch OD, has been used extensively. A tubing layout typical of the older plants is shown in *Fig.* 4. The tubes are in racks, covered troughs, or pulled through a larger pipe. Along with development of the small-case instrument, a new concept in tubing came on the scene—the bundled tubing assembly pictured in *Fig.* 5. Either plastic or metal tubes are available in lengths up to 500 feet with as many as 19 tubes in one bundle. The outside sheath can be had in many forms and materials to give protection in corrosive atmospheres, or to minimize mechanical strains and wearing. Even though the length and number of tubes have increased in the newer plants, the bundled tubing assembly has greatly diminished the installed cost of the pneumatic instrumentation system.

A natural consequence to the miniature instrument was the advent of the graphic panel, shown in *Fig.* 6. The small case fitted ideally into this scheme—a visual operating flow sheet. Symbols for major equipment in the process are painted on the panel or fabricated from plastic or metal. Colored lines are used to delineate various fluid lines. This enables quicker training of operators, faster evaluation of trouble or conditions causing upset and has an esthetic value that can be exploited for advertising. More data in less space, better control and a more psychologically pleasing appearance have resulted from the innovation of the miniature instrument.

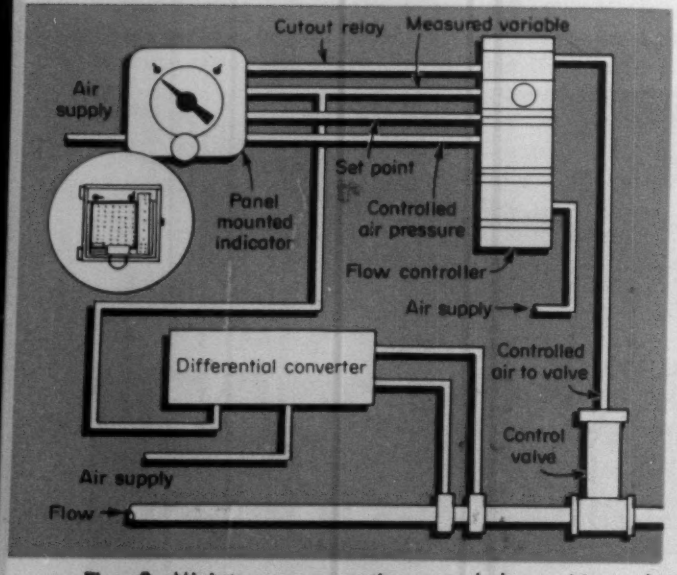


Fig. 3—Miniature pneumatic control loop. Note the increase from two to four lines between the field mounted controller and the panel mounted recorder.

Electronic Instrumentation

A few years ago a new competitor appeared on the instrumentation horizon—the electronic process control system. It has the same purpose, and same control loop arrangement as the pneumatic. It appeared at a most propitious time, the period of miniaturization. So, the electronic instruments started with the small case.

Loop elements are similar in pneumatic and electronic systems. Electronic transmitter works on the same basic principle as the pneumatic: Conversion of a motion of a primary measuring device into a signal, here an electrical voltage or current; or conversion of a small millivoltage, as that generated by a thermocouple, into a compatible output signal. The three control functions of proportional band, reset and rate action are done with electrical resistances and capacitances in the electronic amplifiers.

Elements in a present day, typical electronic control loop are shown in *Fig.* 7. Note that there are five, rather than the pneumatic three. The two extra components are the manual control station, and the electropneumatic relay for transducing the output control signal into a 3 to 15 psig air signal.

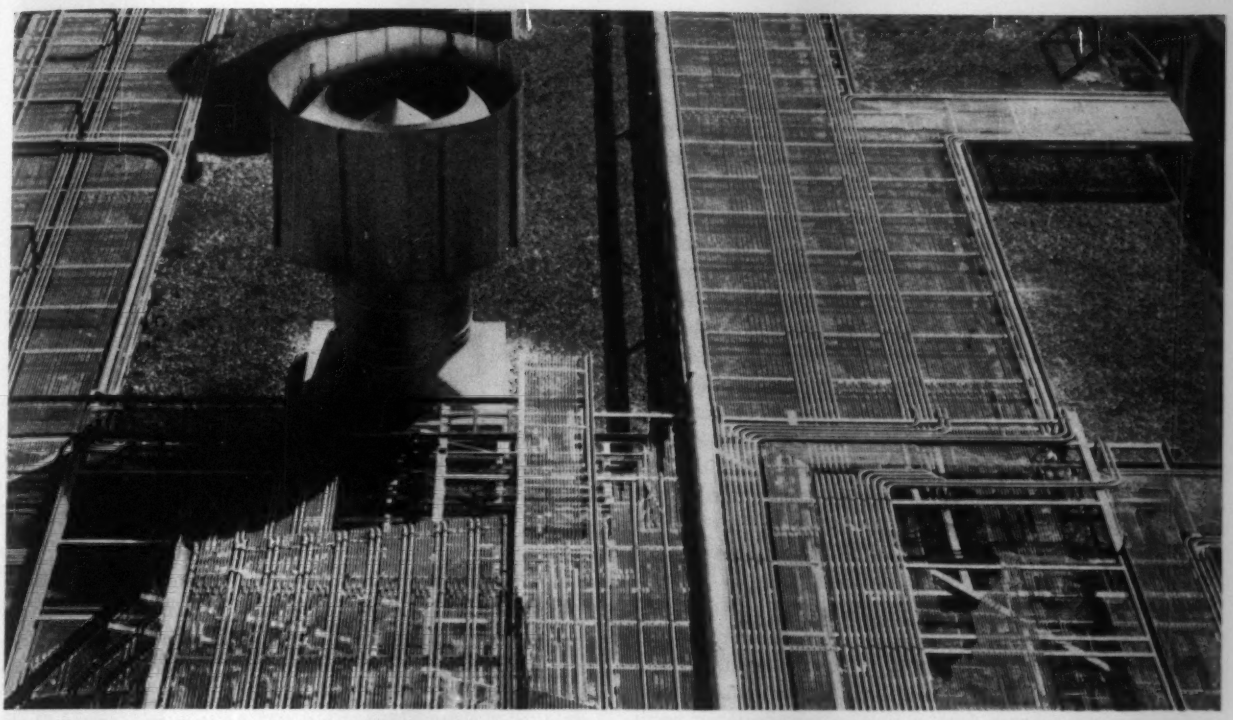


Fig. 4—Conventional tubing installation. Tubes may be mounted on racks, in covered troughs or grouped in larger pipe.

This allows use of the prevalent diaphragm motor control valve. There is an electrohydraulic valve operator available, eliminating the need for the fifth component, the power relay transducer. The same spans and ranges of the three control functions are available as standard with the electronic as with the pneumatic. The electronic includes the ancillary control features as cascade, ratio, multiplication, summing, totalizing, digital integration of a variable rate, etc. as does the pneumatic.

The electronic system appeared on the market in response to a demand due to several conditions that are beyond the pale of the pneumatic. Signal transmission from the transmitter to the recorder and controller, and from the controller to the electropneumatic transducer is practically instantaneous. Signals can be sent over long distances without any appreciable lag. A common ground for many incoming and outgoing signals can be used with the electronic, minimizing the number of transmission wires. It is not necessary to field mount the controller. Explosion proof design is offered for hazardous locations of the field components.

▶ Transmission of Signals

Since the pneumatic system has been extant for such a long time, it was only natural that a standard transmission signal be adopted for all manufacturers. Consequently, all leading manufacturers offer an output range of 3 to 15 psig air pressure on all transmitters and controllers. Other output ranges are available to support existing installations of older equipment, but all offer the standard SAMA (Scientific Apparatus Manufacturers Association) range.

The 3 psig output air signal for zero or minimum range is for a "live" zero, to avoid offset, and allow easy establishment of the zero point and range. This standardization allows selection of loop components from various manufacturers, permitting an optimum arrangement of cost versus accuracy, performance, sensitivity, ruggedness, etc. in any one control loop. True, this means an increase of spare parts, maintenance schedules, etc., but these are minor items compared with flexibility of choice, and the stimulation of better products by competition on all items.

There are six manufacturers of the complete loop miniature instrument line in the pneumatic, and there are at least six more that manufacture components that fit into the standardized system. This does not include the control valve or pneumatic motor operator manufacturers.

Electronic process control instrument manufacturers (two predominant American companies), being relatively new, are not at present standardized in signal transmission. Loop components are not interchangeable. Therefore, any comparison must be made between Brand *A* and Brand *B* of the electronic, and the general pneumatic field. It is probable that it will be several years before more manufacturers gain a competitive position in the miniature electronic process field, thereby

expediting a standardization comparable to that of the pneumatic.

Brand *A* uses a differential transformer to convert motion into an electrical signal at the transmitter. The parallel signals from the transmitter to the recorder and controller, are 0.0 to 0.5 volts, 60 cycle, at a 58-degree leading phase angle. A phase sensitive rectifier and amplifier in the controller make the error detection and correction. Output to the electropneumatic relay from the controller is a 4 to 8-milliamp dc signal into a 18,000-ohm impedance. Output voltage is 72 to 144-volts dc. A constant voltage regualtor is required for power. Harmonic filtering is recommended. There are two or three vacuum tubes, depending on the control functions, in a normal control loop. Shielded wire is recommended between transmitter and recorder-controller.

Brand *B* of the electronic process control instrumentation is an all dc system. Motion of the primary measuring device in the transmitter positions a beam or flag in an oscillator coil. Beam motion detunes the coil and causes more or less current to flow through the rectifying tube in the transmitter. The output current has a portion fed back for a null position balance. Output is 0.5 to 5.0 milliamps dc, into a maximum of 3000-ohms line and load resistance. The transmitted signal goes to the receiver (either an indicator or recorder) and then in series to the controller, after it has been amplified in the recorder.

The vacuum tube amplifier in the controller detects a $\pm$22-volt dc signal from the set point amplifier in the recorder. Output from the controller is 0.5 to 5.0 milliamps dc into a 3000-ohm load. The electropneumatic relay is a valve positioner which compares actual valve stem position with that required by the control signal and further amplifies the pneumatic signal to properly position the valve. Nominal line voltage of 115 volts ac is the required power supply, with normal fluctuations having little effect on the output signals. There may be up to nine vacuum tubes in a normal control loop, depending on the control functions, with a vacuum tube and high voltage (380 volt) plate supply transformer in the motion type of transmitter.

System Characteristics

Overall loop accuracy of both electronic and pneumatic systems is the same industrial standard of $\pm\frac{1}{2}$ per cent. As for speed of response, magnitude ratio and phase shifts for sinusoidal inputs, Boyd[1] (in a paper that argues *for* the electronic) has made an excellent comparison of electronic vs pneumatic loop performance. He states, ". . . It can be seen from the phase shift and magnitude

[1]References are tabulated at end of article.

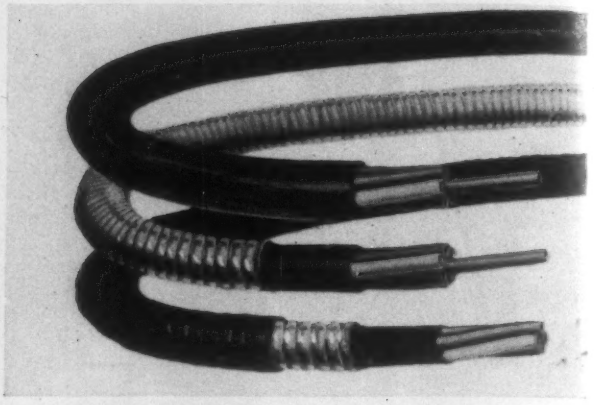


Fig. 5—Pneumatic tubes protected by thermoplastic sheath or combinations of thermoplastic sheath and armor. These are corrosion resistant types.

ratios, that while the performance of the electronic controller is not as good as that of the pneumatic valve mounted controllers, it is better than the performance of the pneumatic controllers mounted on a panel board 100 ft away. This proves a rude awakening from our visions of high speed performance from an electronic controller. The fact is that although the transmission and control is practically instantaneous there still remains the valve to be moved by the controler and the air pilots supplied with the electronic controller did not have the air capacity of some of the pneumatic controllers . . . If one element in the control system is slow, it slows the whole system."

Since this statement is at least two years old, the reader can assume that manufacturers are developing the electropneumatic relay for better performance characteristics. However, to date no new data have been published to refute this statement. There has been no published performance data on the all-electric system utilizing the self-contained electrohydraulic valve operator. It's of interest to note that a leading pneumatic manufacturer is planning to release an electropneumatic transducer, supposedly compatible with both brands of the electronic instruments, late this fall. Perhaps its characteristics will improve electronic loop control. Note also that this is favorable to pneumatic "short loop", having the controller mounted at the valve (the four-tube line installation between the control room and field transmitters and valves).

In studies of the sensitivities of both systems, Tivy[2] states that the available sensitivity and reproducibility of both systems is comparable and beyond the limit of practical requirements.

System Components

Both the pneumatic and electronic systems have process transmitters covering the greatest ma-

jority of applications. Both systems have range suppression features for the measurement of basic process variables. Actually, the word supression is a minomer. It is an amplification of a portion of the range—a pressure transmitter with a nominal range of 0 to 500 psig can be "suppressed" for a full signal output for a 50 psig span anywhere within the range, such as 400 to 450 psig. Conversion of low millivoltage signals (from thermocouples, pH and conductivity meter, etc.) to pneumatic output signals with nonmechanical, servo-type, null balance potentiometers, is accomplished with several types of transducers. Converters for both brands of the electronic are available for the requisite output signal.

Multiple parallel receivers can be used to present data from a common transmitter in both systems. Problems of weatherproofing outdoor installations to counteract zero shift and range change due to ambient thermal changes are about the same for both systems. A wide choice of materials of construction to meet most services is offered in both systems. Output indicators for blind transmitters are available for both.

The problem of explosion-proofing components in a transmitter or electropneumatic relay as well as a completely enclosed electropneumatic unit is a fairly extensive one today. The various requirements of the client, his insuring agency, and the criteria of the Underwriters, Factory Mutual, NEMA, and the other codes must be carefully studied when the electronic brands are considered. What is offered as a manufacturer's standard for explosion-proofing may not satisfy a particular code.

Recommended limits of transmission are: 1200 feet for pneumatic; 1000 feet for Brand *A*, with special application to the manufacturer for longer distance; up to 100 miles for Brand *B* (depending on total output load).

Miniature strip chart recorders are available in both systems. The pneumatic recorders have the *Automatic-Manual* station integral with the case. Both electronic brands have a separate case for the manual control. Four of the pneumatic recorders, and both electronic brands have 3-inch chart width. The largest panel front space for a pneumatic recorder of this chart width is 28 square inches. Brand *A* takes approximately 22.5 square inches and Brand *B* 24.5 square inches. When required, the addition of the manual control case means that Brand *A* consumes approximately 31 square inches and *B* 37 square inches.

There are two pneumatic manufacturers that have 4-inch chart widths. These recorders require 36 square inches of panel front. However, the 4-inch chart gives about 33% more readability and accuracy of control point setting. Two recording pens are available in the pneumatic with a third pointer for indication of another variable. Both brands of the electronic are limited to one recording pen at present.

Recorders of both systems are available in "pull out" construction, permitting routine calibration and maintenance from the panel front. Several pneumatic brands and Brand *A* of the electronic can be obtained with the feature of sealing in the control point and signal to the final element with the removal of the recorder from the panel. Plug-in components for ease of replacement and shop maintenance are standard for both systems.

Pneumatic chart drives are available in the miniature pneumatic recorders for location in hazardous areas. Separate round and vertical scale indicating controllers (indicator with set point knob) are available in Brand *A* and the pneumatic. Vertical scale indicating controllers can be obtained from Brand *B*. Note that Brand *A* may have the set point indicator and knob on its controller—but this would require panel mounting of the controller,

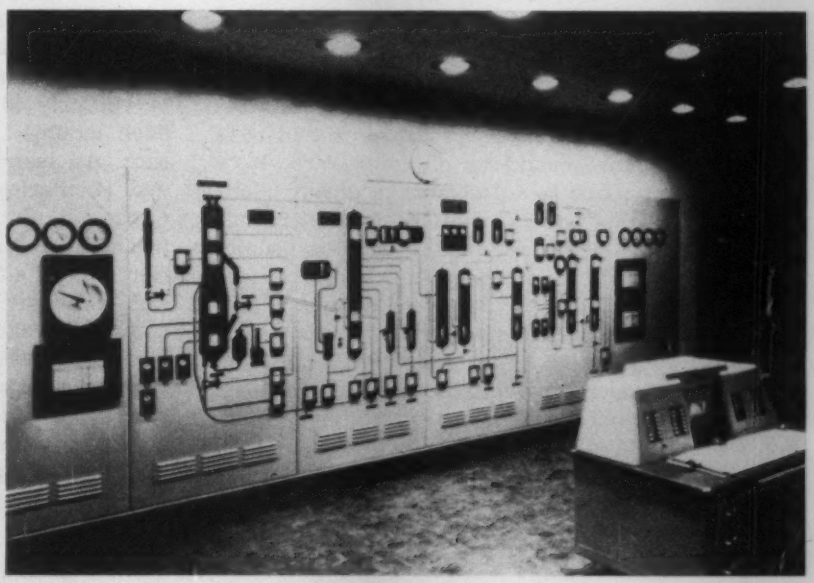


Fig. 6—Typical graphic panel showing the tremendous saving in space with miniature instruments and the improvement in visual comprehension.

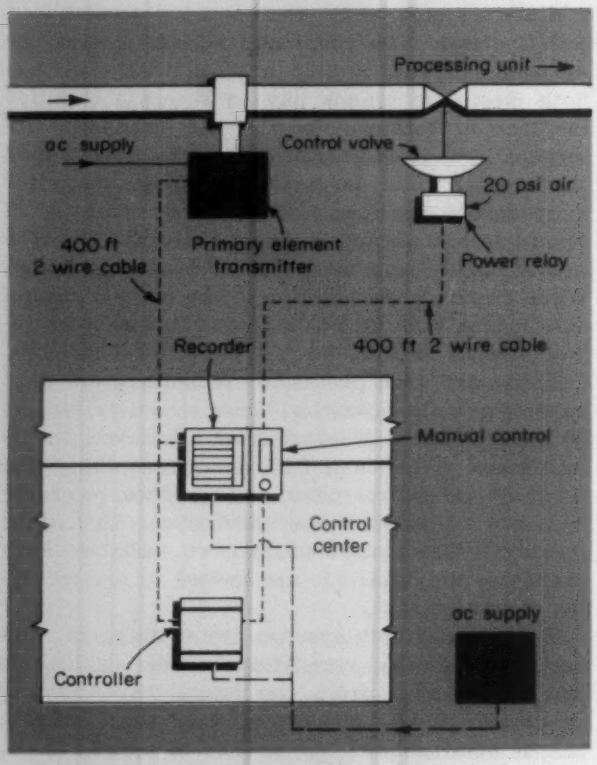


Fig. 7—Typical electronic instrument control loop containing five elements rather than three contained in the pneumatic system.

consuming a total of 55 square inches of panel space.

The standard modes of control—proportional band, reset rate and direct derivative action—are standard design features of both systems. Ranges of these modes are comparable in both. A device is made by one pneumatic manufacturer which gives an inverse derivative function—a temporary widening of the proportional band as the pen deviates from the set point.

Pneumatic controllers can be field-mounted on the valve, rack mounted on the panel rear, or plugged into the rear of the recorder case. Electronic controllers are suitable for rack mounting on panel rear, or flush mounting on panel front. Field mounting is not necessary due to instantaneous signal transmission. There are pros and cons about front panel mounting of controllers. It is conceded that there is an advantage during plant start-up for the panel mounted controller, but this is a minor one. Once tuned-in there is usually a long period before resetting the values of the control modes. There has been no serious disadvantage in the rear or remotely located pneumatic controller. Panel space consumption with the flush mounted controller goes up to 80 per cent per loop.

Units for summing, totalizing, multiplying, dividing, etc. of multiple signals are available in both systems. The electronic units and circuits are custom built and not shown as standard items.

As mentioned before, the control valve, as an engineered variable restriction in the process, is generally the most widely used and satisfactory final element in today's control loop. The pneumatic diaphragm motor control valve is universally used. An electrohydraulic operator has been developed to complete the all-electronic loop. It is higher in price and its speed and stem thrusts are slightly lower than those offered as standard pneumatic motors. However, these points are not often limiting factors and the electrohydraulic operator can be used in the majority of process applications.

It has been argued that certain electrical measurements, such as the thermocouple, pH and conductivity meters, etc., make the electronic system more compatible. This is not necessarily true. The final element in the individual loop should be the determining factor. This applies also to the analyzing type of meter when used in a control application. Infrared, thermal conductivity, colorometric, specific gravity measurements, etc., have an electrical output, but if a control point is to be maintained, note how this is to be done. Generally, stroking a control valve will be the optimum way of maintaining a desired control point, satisfying the majority of applications. This forces serious consideration of the pneumatic, not a cursory rejection.

Cases such as heating with a saturable core reactor control, Thymatrol control of pump speed, variable motor control of large valve or gates, unattended pump stations on long pipe lines, etc., certainly preclude the pneumatic and favor the all-electronic system with elimination of the electropneumatic relay. Mass production of a modulating electric operator, probably of the amplidyne type, to give a high speed, high thrust valve motor at competitive prices would greatly enhance the position of the electronic process control instrumentation as a general competitor.

▶ Panel Arrangements

A cost comparison of a typical panel, conventional or graphic, is not intended here. However, several points should be remembered when making such an evaluation. Note the panel space requirements of each system, as previously mentioned, particularly if the electronic controller is to be flush mounted. Study the number of cut-outs for each. An instrument air header, associated piping and ancillaries are avoided with the use of the electronic. Consider the size and space of components for cascade control, ratio control, integration, etc. of either system.

A technique for an optimum of panel cost versus control developed for particularly large graphic panels, is the use of indicating controllers and deviation indicators on the main panel, with arrangements for plugging into banks of miniature recorders to observe trends, analyze data, collect information, etc. The pneumatic system presently has two advantages in this method: (1) The availability of two pen recorders, and (2) a large differential in cost between the recorder controller

and indicator controller. The average dollar difference between a pneumatic recorder controller and an indicator controller is about $100. The larger the panel, the more two-pen recorders can be provided to handle every anticipated need for recording. The average dollar difference between an electronic indicator controller and recorder controller is less than $50.

Another point to watch is the power consumption of the electronic loop components located in the control room. The average is 40 watts per loop. More loops located in a control room may mean more heat dissipation capacity of the air handling or air conditioning system.

The pneumatic instrument system requires a source of clean, dry air. The usual arrangement consists of an oil-free compressor, automatically regenerated air dryer, and an air receiver with its auxiliary equipment of relief valves, pressure gages, switches, and valves, etc. An emergency supply is contained in a large air receiver—a small compressor can be used to fill a large capacity for a reasonable duration of emergency supply. Automatic crossover to take the output of another compressor (generally the plant air compressor) into the air dryer upon failure of the instrument air supply is easily accomplished. Note that even a plant power failure is handled by the receiver capacity.

At present both of the electronic brands, when using the electropneumatic relay, also require a supply of clean dry air at the valve, though not as much capacity. Brand *A* of the electronic requires a source of regulated filtered 110 volts ac. Brand *B* requires 110 volts ac line voltage. An emergency power supply is usually provided by a separate generator, engine or turbine driven, with automatic throw-over on power failure.

Standard techniques should be used to determine amortization costs of power (air or electricity) to complete the evaluation.

▶ Data Recording and Processing

Much has been transcribed elsewhere about trends toward the use of automatic data handling and logging equipment in the process industries, and the eventuality of collecting the information in a central location and sending it into computers and feeding it back into the process loops as control information. The justification of automatic data handling and logging is a separate thesis and will not be discussed here. Overall prospect of the plant automatic computer as an economic feasibility is in the distant future. We shall look into the present status of automatic data handling and logging and try to evaluate the relationship and compatibility of the pneumatic and electronic systems. We shall consider how the transmission signals already discussed fit into the first part of the automatic data handling and logging unit, namely, the analog to digital conversion.

Data reduction systems presently available have various input signal requirements and several methods of arriving at the digital output from the analog input. Lack of standardization also applies to the automatic data handling and logging units; in fact, quite a few are custom made to suit individual requirements. This poses a problem if, in the engineering of the instrumentation for a new plant, it is planned to provide for a future data logging system. Examine four predominant methods for analog to digital conversion:

1. Converting signal input to a mechanical shaft or code plate position. Generally uses a low voltage dc signal input into a null balance, servomotor type potentiometer. Shaft position determines binary signal to automatic typewriter, card or tape punches, magnetic tape pulse, etc.

2. Subtracting reference voltages in decreasing magnitude from the input voltage in steps (by relays) until a match with a constant reference voltage is attained. Usually a higher input voltage, about 100 volts, is required. Speed, reliability and life are about the same as the mechanical method. Arbitrary functions such as square root extraction are difficult to obtain.

3. Pulse generated in proportion to input voltage, usually 100 volt maximum.

4. Comparing input signal with time varying reference. A low voltage, either ac or dc is generated at a rate linear with time. At the null point a signal is sent to the digital counter, usually through a binary relay arrangement. This type is also marketed di-

THE AUTHOR

A. JAMES WALDRON has been active in instrumentation since his service as a fire control officer aboard the *U.S.S. Mobile* and the *U.S.S. New Jersey*. Range of his experience includes test engineering on rocket engines, application engineering for construction companies on the measurement and control of chemical, petrochemical, petroleum and atomic energy processes, and sales engineering of meters and data reduction systems. His present position with the Catalytic Construction Company of Philadelphia entails the responsibilities of instrument engineer for petroleum, chemical and atomic energy plants, from design to start up. Mr. Waldron graduated from Carnegie Tech and is a national chairman of the Instrument Society of America.

TABLE 1—Summary of Comparison Between Systems

	Pneumatic	Electronic	
		Brand A	Brand B
1. Loop elements	Transmitter Recorder Controller Final element (Controller may be plugged into recorder on short transmission distances)	Transmitter Recorder Controller Manual control station Electropneumatic relay Final element (Relay may be eliminated with use of electrohydraulic operator)	Transmitter Recorder Controller Manual control station Electropneumatic valve positioner Final element (Valve positioner may be eliminated with use of electrohydraulic operator)
2. Loop accuracy	±½% Full range	±½% Full range	±½% Full range
3. Signal transmission			
a. From transmitter to controller	3-15 psig	0.0 to 0.5 volts 60 cycle ac	0.5 to 5.0 ma dc
1. Distance	500 feet (If controller is field mounted, transmitter may be 1200 feet from control room)	1000 feet, with application to manufacturer for longer distances	Up to 100 miles, depending on load resistance
2. Conductor	Tubing, plastic or metal	Shielded two wire, one a common ground	Two wire, one a common ground
b. From controller to final element	3-15 psig	4 to 8 ma dc	0.5 to 5.0 ma dc
1. Distance	500 feet	1000 feet, with application to manufacturer for longer distances	Up to 100 miles, depending on load resistance
2. Conductor	Tubing, plastic or metal. Two per loop, if controller is panel mounted, four per loop if field mounted	Two wire, one a common ground for both brands	
4. Power supply	Clean, dry air	110 volt ac, regulated, with harmonic filtering. Clean, dry air if pneumatic final element used	110 volt ac line voltage. Clean, dry air if pneumatic final element used
5. Transmitters			
Weatherproof	Yes	Yes	Yes
Explosion proof		Yes. Check for conformance to particular code for both brands	
Multiple receivers	Yes	Yes	Yes
Suppressed range	Yes	Yes	Yes
Converters for low emf signals (thermocouple, pH, conductivity, etc.)	Yes	Yes	Yes
Output Gage	Small pressure gage	Voltmeter	Ammeter
6. Recorders			
Chart width	3 inch-4 manufacturers 4 inch-2 manufacturers	3 inch	3 inch
Multiple pen	2 pen	1 pen	1 pen
Auto-Manual station	Integral in recorder case	Separate case	Separate case
Panel space	Max. of 28 sq inch for 3 inch chart case. 36 sq inch for 4 inch case	31 sq inch with manual control case. 55 sq inch including panel mounted controller	37 sq inch with manual control case. 61 sq inch including panel mounted controller
Integrator	Yes, up to 8 digit	Yes, up to 8 digit. (not shown as standard in catalog)	Yes, up to 8 digit (not shown as standard in catalog)
7. Controllers			
Control modes	Proportional band, derivative action, automatic reset (fast and slow) available from each		
Mounting.	Field, plug into rear of recorder, and rack mounting	Rack, or flush panel mounting for both brands. Not necessary to field mount controller	
Special features (cascade, ratio, etc.)	Yes	Yes. Not shown as standard in catalog	Yes. Not shown as standard in catalog
8. Final element	Diaphragm motor or cylinder operated from 3-15 psig control signal	If pneumatic operator used, output signal converted to 3-15 psig signal. Electrohydraulic operator available, eliminating power relay	If pneumatic operator used, valve positioner relay converts to 3-15 psig. Electrohydraulic operator available, eliminating valve positioner relay
9. Compatible with data reduction equipment	Yes	Yes	Yes
10. No. of manufacturer's of complete line	6	1	1

rectly for pneumatic instrumentation. A time varying reference air pressure, 3 to 15 psig, is impressed on one side of a diaphragm. Comparison is made with the 3 to 15 psig signal from a standard pneumatic transmitter. At null a contact on the diaphragm completes a circuit. This stops a synchronous motor which has been driving the air blower and also has a rheostat geared to the motor shaft. The final position of this variable resistance gives a voltage output to the analog to digital conversion unit.

Note the conversions necessary. It might be required to rectify and amplify the transmitted signal of Brand *A* to conform to the automatic data handling and logging unit selected. Additional resistances in the output of Brand *B* may be mandatory to match its automatic data handling and logging system and may affect the transmission distance, or if that distance has been established previously, requirements of amplification will add to the system. It may be necessary to transduce the 3 to 15 psig air signal to suit the automatic data handling and logging. Most manufacturers of automatic data handling and logging units are able to supply the necessary converters, amplifiers and/or transducers.

A word about scanning. Most automatic data handling and logging systems provide for scanning all recorded points, compare them with preset boundary conditions, and separately read out off-normal signals. The same switching used to select the point for printing has extra contacts for the scanning circuits and their associated memory circuits. Monitoring, which is the continual comparison with limit boundaries, doesn't wait for the step switch to come around to it. Upon abnormal conditions, a direct circuit to the off-normal print cycle is closed and unless more points go awry, an off-normal print cycle is actuated. Storage circuits are designed to handle the rapid transgressions of many points. Monitoring is simply accomplished in the pneumatic by preset pressure switches in the transmitted air lines, in the electronic by small adjustable Wheatstone bridge circuits.

The generalization might be made that at this time both the pneumatic and electronic systems are compatible with the automatic data handling and logging equipment now offered when process control is involved. Straight recording of large amounts of data over a long transmission distance is definitely for an electronic system.

▶ Making the Comparison

No attempt is made to delve into overall investment costs, amortization, maintenance and servicing, etc. This is a subject sufficient for a separate paper, pointing out the minutiae of details to be considered. As an example, two cases in point are as follows:

1. Use of output gages for blind transmitters. It has been only recently that a lower cost field indicator was made available for Brand *A*. Use of an output gage on a Brand *B* transmitter may limit a transmission distance. Explosion-proofing, if required, poses another point for study.

2. Linearizing a square root function and integrating a rate signal means a complete analysis of the number and size of components, interconnections, power requirements, and panel space.

Actually, a comparison between an old proved system and a relatively new one, TABLE 1, is a bit unfair. Both are in the process of continual development—the electronic certainly refining at a faster rate. It will find a goodly share of the market, but does not portend to completely replace the pneumatic. Active consideration of both systems by potential users can have but one salutary effect—better design, more imaginative devices and applications, and lower costs. This is the wonderful attribute of competition in our free enterprise economy. Therefore, this paper should have a definite time limit for reader consideration.

The author feels that the statement, "Good Only Until December 31, 1957" should be overprinted on each page. By then the manufacturers and perhaps more competitors, will have overcome some of their limitations. Accordingly, statements indicating the present state of the art should be reconsidered at that time. With new techniques of transistorization, microminiaturization and modular component design, the comments herein could well be obsolete.

It is possible, however, to offer more timeless advice. Beware of generalizations such as: One system's installed cost is lower than the other; one system's panel will be the cheaper to install; and the maintenance and downtime of one is better than the other, is more versatile, more compatible with future trends, etc. The only conclusion to be reached now is this: Each process or plant is a case unto itself, a case for rational study by competent, impartial persons familiar with all aspects of both the pneumatic and electronic systems.

REFERENCES

1. D. Boyd, "Why Electronic Process Control," *Journal of the Instrument Society of America*, Nov. 1954.
2. V. Tivy, "Instrumentation for the Process Industries—Pneumatic or Electronic," *Journal of the Instrument Society of America*, Feb. 1956.

Copies of Articles Available

In many instances a reader may desire to have extra copies of feature articles for further study, for specialized circulation within his plant, or for a reference library. As a regular service to readers, we will be happy to send copies of desired articles as long as the supply lasts. To obtain extra copies, just fill out one of the special business reply cards included in this issue.

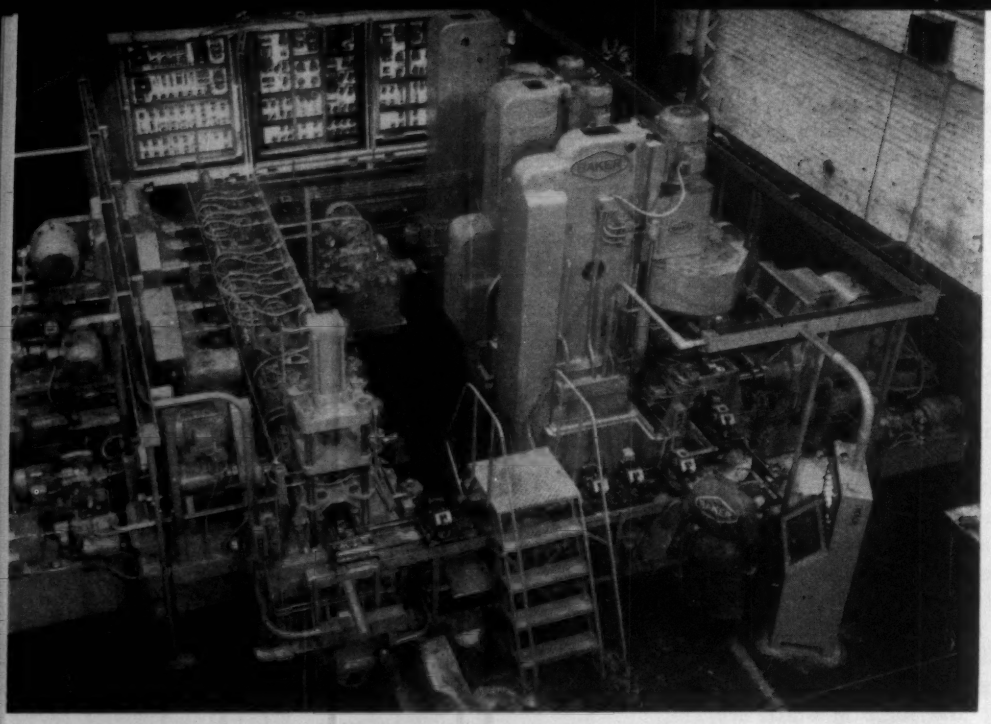


Fig. 1—Valve body transfer machining unit set up in the builder's shop. Operator loads and unloads pallets which index counterclockwise around the rectangular layout. Different part models are accommodated by tooling and fixture changes which are practical for runs as small as 6000 to 8000 pieces.

VARIETY OF PARTS FLOWS FROM

VERSATILE TRANSFER MACHINE

THOUGH AUTOMOBILE PRODUCERS have used transfer machines for several years, many other industries have just begun to apply such machines. The valvemaking industry is a case in point. The typical valvemaker is faced with the same condition that has been considered a restriction on application of automation in many plants—relatively small runs of individual parts or models. Lack of versatility or excessive changeover costs have been major considerations. But such limitations are not necessary features of automated facilities. A major valve producer has had an automated transfer unit constructed, *Fig.* 1, to machine seven sizes of bodies for flanged bonnet type gate valves. The unit can also be tooled for globe valve bodies. Design of the unit is such that lots of 6000 to 8000 pieces are practical.

Essentially the facility is an arrangement that shuttles pallets around a rectangular path along which machining units are positioned. The rough steel forgings for the bodies are chucked in two-jaw chucks on individual pallets. The chucking establishes the flow section centerline and locates the bonnet surface of the part for vertical operations, *Fig.* 2. The jaws are interchangeable to accommodate model variations. Pallets are loose plates which slide on hardened ways between guide rails and are located and clamped at each station by hydraulically actuated pins.

Machining operations are performed by 12 separate units arranged along the two long sides of the pallet path. Each unit is a separate machine having its own base and power unit, but all units and the shuttling equipment are co-ordinated by interlocking controls. For the most part these machining units are standard equipment built by Baker Brothers Inc. who built this entire facility for the Hancock Valve Division of Manning, Maxwell and Moore. Machining operations are performed on three areas of the valve bodies: Bonnet and seating surfaces, which are machined by four vertical units; surfaces at one end of the flow line through the valve, which are machined by four horizontal units along one side of the transfer unit; and surfaces at the other end of the flow line, which are machined by the four horizontal units along the return side of the transfer machine. Horizontal units on one side of the facility are duplicates of the horizontal units on the opposite side.

▶ How It Works

A single operator controls the entire facility. He loads each part on a pallet and tightens the jaws. When the workpiece is in place the operator pushes a button to initiate the first cycle. In suc-

cessive cycles the pallet is indexed through 28 stations along the machining legs of the layout and across the ends of the unit. The pallets are indexed along each machining leg by a hydraulically actuated indexing bar for that leg. Each bar is a round shaft with a lug for each station positioned the length of the bar. By means of a rack and spline arrangement, a hydraulic cylinder rotates the bar so that the lugs will engage the pallets. Another hydraulic cylinder moves the bar lengthwise, indexing the pallets. The lugs are then rotated out of engagement and the bar returns to its starting position. The pallets are transported between the machining legs by roller chain drives co-ordinated with the two index bars.

When the pallet is in one of the 17 stations where machining operations may be performed, it is located and clamped by hydraulic power. The pallet is positioned along the length and width of the index path by a wedge shaped shot pin which moves horizontally into a recess in the side of the pallet, *Fig.* 2, and seats the pallet against a locating rail on the opposite side. A clamping pin is then cammed down on each corner of the pallet by the action of two hydraulic cylinders at each station.

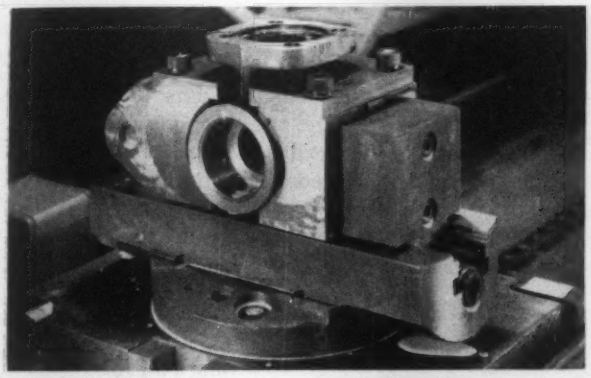


Fig. 2—A machined forging is shown here as it returns on the pallet for unloading by the operator. The vee blocks contacting the workpiece are interchangeable to handle various models.

Vertical machining operations may be performed at seven stations, and horizontal operations at 16 stations, *Fig.* 3. Six of the vertical operation stations are also stations in which horizontal operations are performed. Depending on the requirements of the part being machined, some spindles may not be performing any work. There are 12 drilling, 6 tapping, 4 reaming, 3 boring, 1 counterboring, 1 broaching and 3 facing operations which may occur each time the machine is cycled.

This transfer machine replaces six other machines of various types. The old machines finished about 19 valve bodies per hour, but the transfer unit averages about 73 per hour depending on part size. Specifically the unit is rated at 100 per cent for 103 bodies per hour of $\frac{3}{8}$-inch size down to 50 bodies per hour of 2-inch size on which $5\frac{1}{4}$ pounds of metal are removed from each piece.

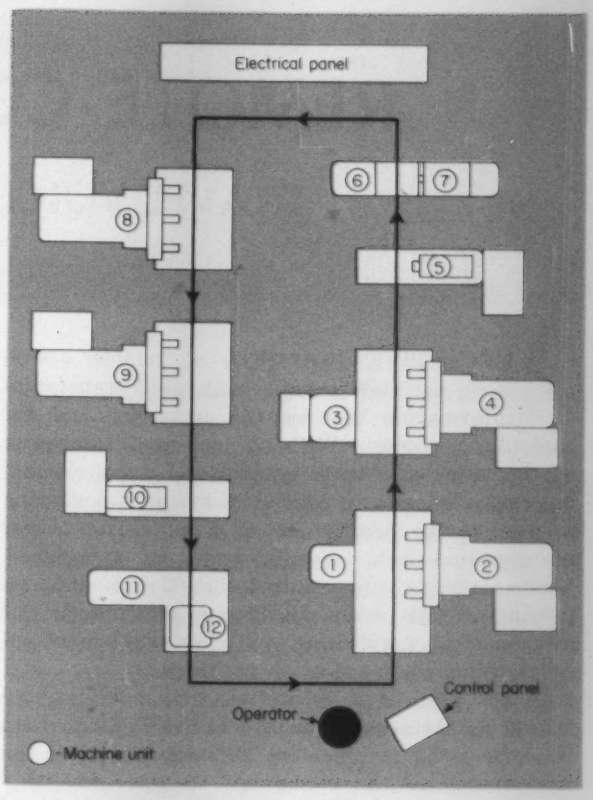


Fig. 3—Plan view of the valve body transfer machine. Not all spindles are required by all valve models for which the unit is used, but operations may be performed at 17 different stations.

Machine Features

Operation of the entire unit is controlled from the operator's control panel. An emergency stop circuit is provided, however, which may be tripped from any point along the machining legs by grasping the safety lines. Chip breakers are ground on the tools, and chips from the operations are disposed of automatically by a conveyor. All units and moving parts are lubricated automatically by a central lubricating system. Tooling change-over time is kept to a minimum by the design of tooling and spindle ends so that lengths are varied in accordance with different part requirements. Pins clamping the pallets down on the ways are spring loaded to wipe the blocks on which they seat, thus eliminating chip problems.

This transfer installation was laid out as a rectangle rather than as an inline machine for several reasons. The number of pallets were kept at a minimum since a straight-line machine would require extra pallets in transit due to increased return distance. The rectangular design requires an area 22 feet by 31 feet, having the desirable effect of keeping the operator fairly close to all areas of the unit and requiring very little floor space.

REMOTE CONTROL SIGNALS

TRAVEL VOICE CIRCUITS

EFFECTIVE CONTROL of remote operations demands reliable and rapid transfer of information between the controlled and the controlling points. With an increased awareness of the value of remote control and a corresponding expanded use, an additional factor is beginning to assume the proportions of a requirement—use of communication circuits must be maximized. Voice messages plus control signals plus data reporting signals must all be accommodated; one method of accomplishing this is to supplement existing voice communication facilities.

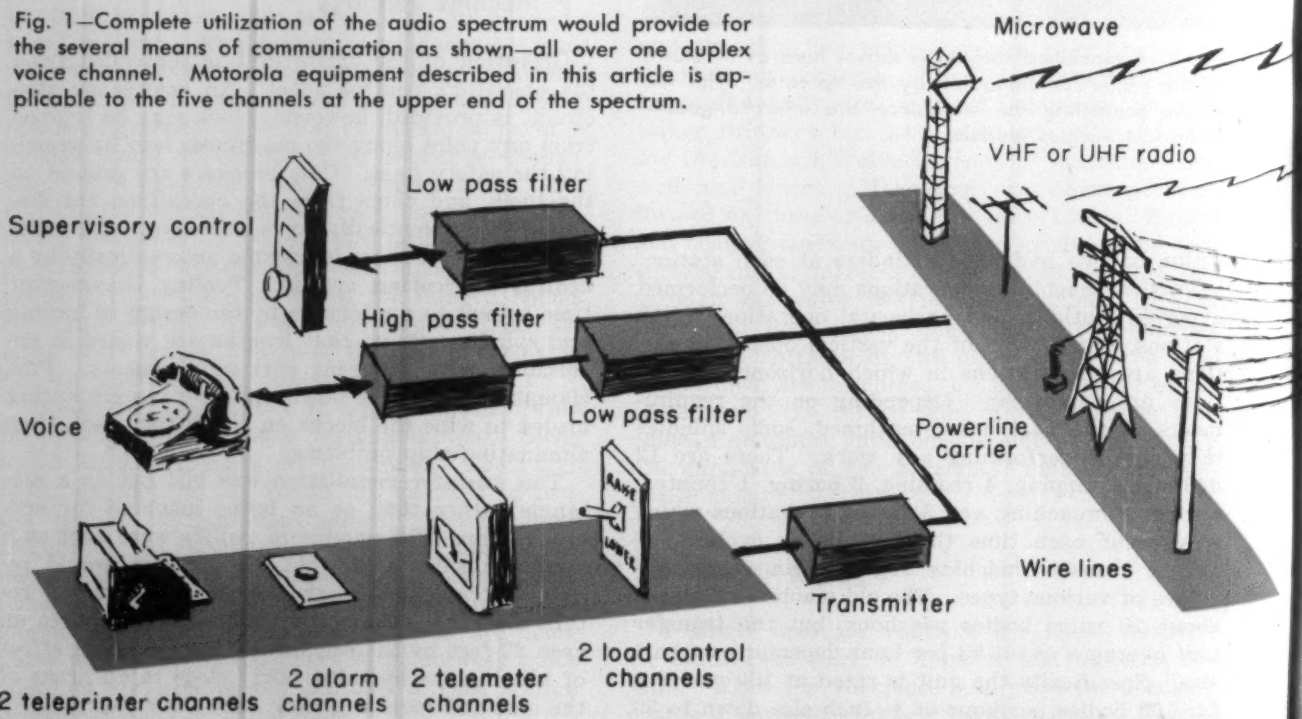
In the case of a voice frequency carrier engineered by Motorola Communications & Electronics Inc., the word "supplement" literally describes the relationship of the equipment to voice facilities. The Motorola frequency-shift VF carrier utilizes the noncritical upper portion of the voice frequency spectrum to obtain up to five carrier channels which can be combined with voice signals without mutual interaction *Fig.* 1. By utilizing the entire audio spectrum for VF carrier, a total of 18 VF carrier channels could be handled on a single voice frequency circuit.

The voice frequency circuit can be transmitted via conventional communication media—wire line, power line carrier, VHF or UHF radio, microwave, or any other medium or combination of media which is relatively distortionless. As to the data transmitted, it is only necessary that it can be translated into coded information.

Basically, either a form of contact or current keying or sinusoidal voltage modulation is employed in transmitting information. As an example, consider telemetering applications. Telemetering refers to the metering of quantities at points and transmitting the data to a remote indicating or recording instrument. Typical quantities which are metered in this way include: Watts, vars, volts, amps, frequency, watt-hours, temperature, position, velocity, acceleration, stress, strain, pressure, flow and level.

Telemetering instruments at the source point, in general, translate the measured data into a pulsed or sinusoidal voltage in the subaudio (0-35 cps) frequency range. Metering impulses can be in the form of open and closed contacts, or in the form of *On-Off* or reversed current keying. Sinusoidal voltage can be varied in frequency to convey information *Fig.* 2. Specifically, the output of a

Fig. 1—Complete utilization of the audio spectrum would provide for the several means of communication as shown—all over one duplex voice channel. Motorola equipment described in this article is applicable to the five channels at the upper end of the spectrum.



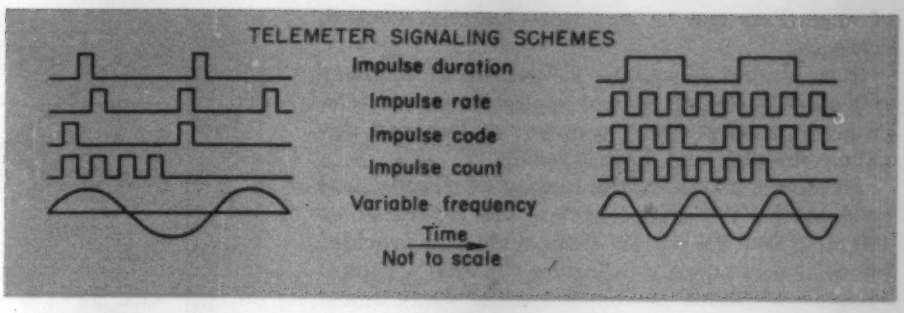


Fig. 2 — Graphic representation of five telemeter signaling schemes. The signals as received from the telemetering instruments are converted to frequency modulated subcarriers in the audio frequency spectrum and transferred back to the original form at the receiver.

telemetering instrument and the input to a terminal device generally will be in one of the following forms:

Impulse duration—pulse length is proportional to metered data in a system employing pulses at a constant repetition rate.

Impulse rate—pulse repetition rate is proportional to metered data in a system employing pulses of constant pulse length.

Impulse count—metered data is indicated by the total number of pulses per reporting time interval in a system employing pulses of constant pulse length at a varying repetition rate.

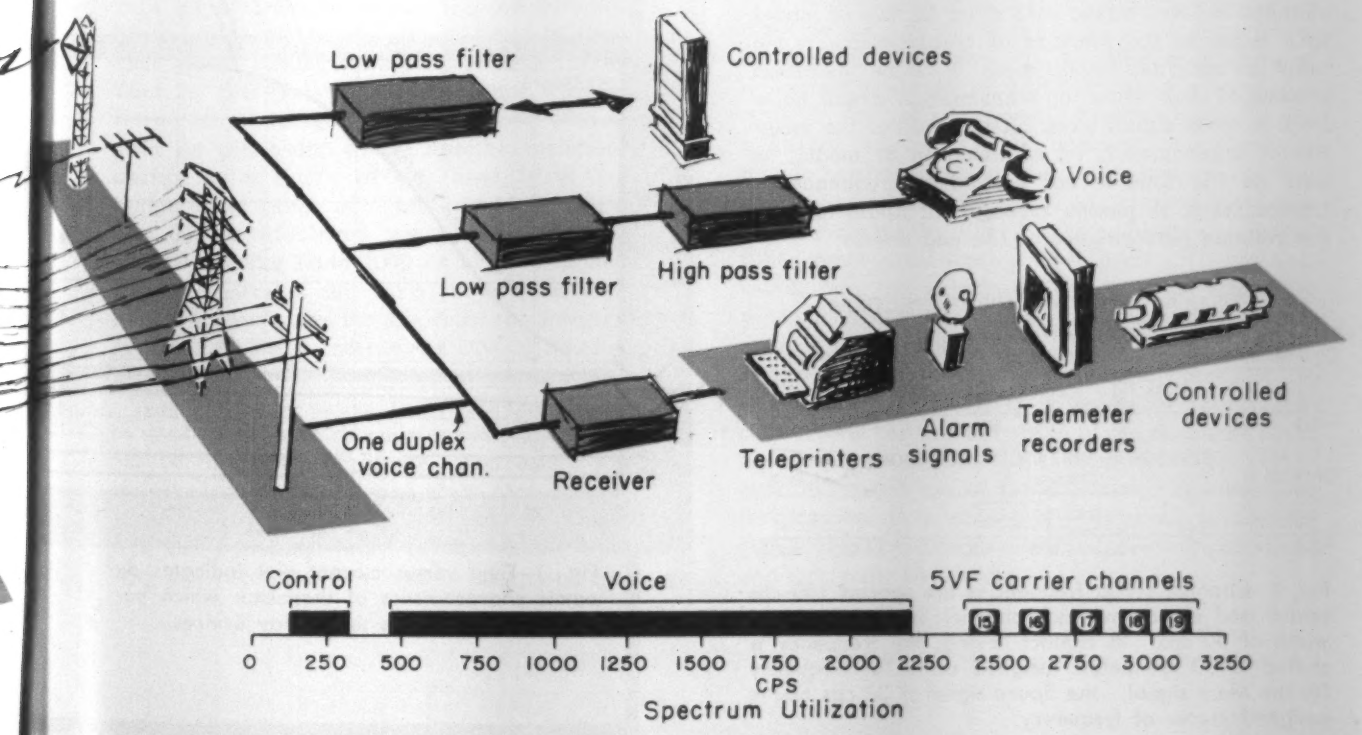
Impulse code—metered data are indicated by code signals consisting of specific configurations of pulses with spaces between pulses.

Variable frequency—frequency of a subaudio sinusoidal voltage (within the 0-35 cps range) is proportional to the metered data.

For transmission via a voice channel by the carrier, the signals are converted to frequency modulated subcarriers in the audio frequency spectrum and transferred back to the original form at the receiver.

Telemetering is generally a simplex operation, i.e., data is transmitted only in one direction and no return circuit is necessary. When a large number of quantities are to be telemetered but the requirements do not demand continuous operation of each telemetering circuit, additional circuit conservation can be realized with selective telemetering. One carrier channel can serve a number of remote instruments as long as only one instrument on the common party line is reporting at one time. This is feasible, of course, since only the instrument observing a change in status needs to be reporting. Control of which instrument is reporting can be by priority or timing or by some form of remote control.

For simple *On-Off* remote control, the VF carrier can provide for the same operation as impulse telemetering where the input and output signals are simply open or closed contacts. For remote flow and load control, such as may be used to operate reversible motors, unattended power installations, adjustable governors, etc., three types



of operations can be signalled—increase, neutral, decrease.

In a general sense, the VF carrier is similarly employed in similar control applications; and telegraph and teleprinting systems; dialing and signaling circuits; and alarm systems.

As shown in *Fig.* 3, the centers of the channels used in the VF carrier system are separated by 150 cps. One VF carrier channel must be provided for each continuously operating function. Typical equipment chassis is supplied as a dual-channel unit, and as has been noted, if a continuous operation is not necessary, a switching arrangement can be used to connect the desired terminal device to the equipment as required.

Three basic types of operation, all frequency modulated or frequency shift techniques, are employed. Impulse type telemetering, teleprinter operation, telegraphy and remote control all employ an audio tone 30 cps above the assigned VF carrier channel center frequency for the *Off* or *Space* signal. For the *On* or *Mark* signal, the frequency is shifted to 30 cps below assigned center frequency. In flow control systems, the signal is normally at the rest or neutral position of the channel center frequency. For *Increase* signals, the frequency is shifted to 30 cps below center frequency and for *Decrease* signals frequency is shifted to 30 cps above channel center frequency. In frequency type telemetering systems, the varying frequency telemetering signal is frequency modulated by the VF carrier transmitter at a deviation of ± 30 cps.

By employing frequency shift or FM techniques, all the advantages that accrue to FM radio systems are present in the Motorola VF carrier. Continuous transmission of tone insures positive operation by both tone presence and frequency, a double check. Regardless of how the tone signal is changed in level, mixed with other signals or mixed with noise in the medium of transmission, it retains its original intelligence. Reliable operation is assured even when the transmission circuit noise level exceeds signal level. Regardless of the medium of transmission, or combination of media, as long as the tone is not shifted in frequency in transmission, it passes through all audio circuits for reliable performance of the end device.

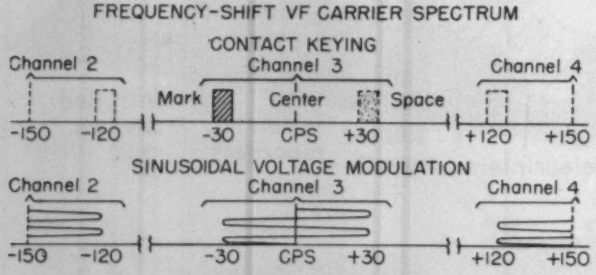


Fig. 3—Channel center frequencies are spaced 150 cps apart, and as shown, each channel occupies a band width of 60 cps. In contact keying, the frequency is shifted to 30 cps below assigned center of frequency for the *Mark* signal; the *Space* signal is 30 cps above assigned center of frequency.

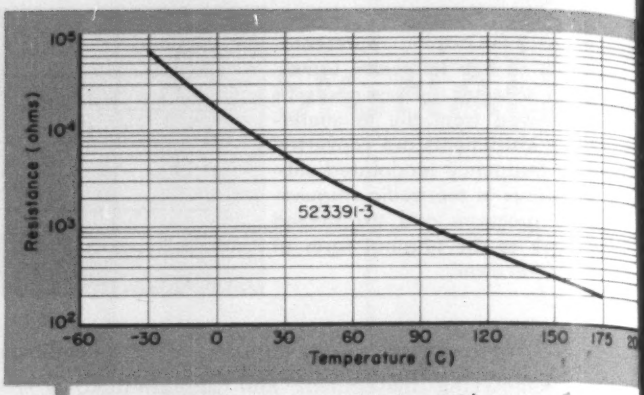


Fig. 1—Variation in resistance with temperature change for a specific Bendix-Friez thermistor illustrates extreme sensitivity which underlies the use of the device in temperature measurement and control applications.

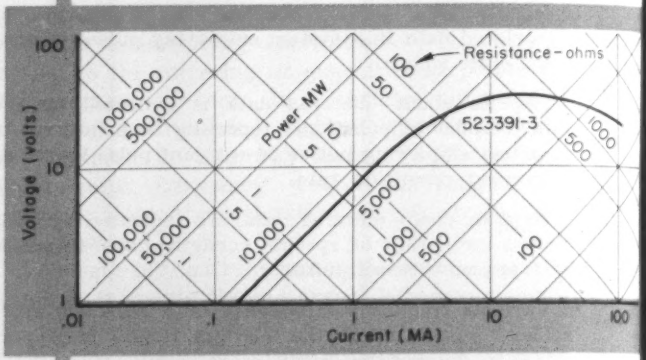


Fig. 2—Static characteristics illustrate drop in resistance due to self-heating of thermistor. The voltage variation with current increase compares to the action of certain gas-filled electron tubes and circuit applications are similar.

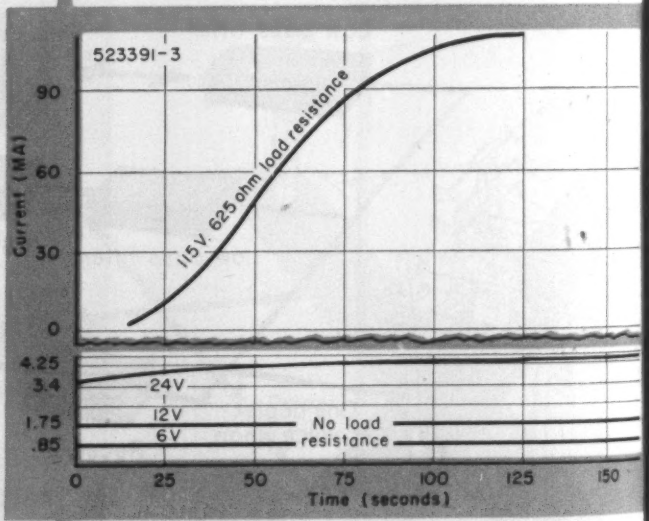


Fig. 3—Time versus current plot indicates dynamic characteristics of thermistor which permit its use in various time delay devices.

THERMALLY SENSITIVE RESISTORS

LINK TEMPERATURE, CURRENT AND TIME

THERMISTORS are temperature sensitive semiconductors possessing a relatively large negative temperature coefficient of resistance i.e., resistance decreases with an increase in temperature. The devices are manufactured by fusing the oxides of certain metals into ceramic-like materials, and as with other semiconductors, the conductivity characteristics are due to impurity in the crystal lattice structure. Recent advancements in manufacturing know-how have resulted in thermistors with the requisite stability, accuracy and reliability for economical use in measurement and control of temperature, switching devices, regulators, volume limiters, pressure gages, time delays and other uses of direct interest to the automation field.

The applications of thermistors generally fall into one of two categories: Those in which the electrical characteristics of the device are controlled by ambient temperature conditions, and those in which the electrical functions are controlled by self-heating which results when the power dissipating capacity of the element is exceeded.

In applications involving the measurement and control of temperature, use is made of the resistance versus temperature properties of thermistors. That is, the variation in resistance with ambient temperature changes. In comparison with a metal such as platinum, whose specific resistance will change by a factor of less than 10 to 1 over a temperature range of −100C to 400C, thermistors can be manufactured with ratios of resistance change varying from 1000 to 1, to 10 million to 1. *Fig.* 1 illustrates the variation in resistance with temperature change for a specific thermistor manufactured by Friez Instrument Div. of Bendix Aviation Corp.

Any circuit sensitive to resistance change may be used to measure thermistor resistance variations due to temperature change. Extremely sensitive circuits can be established since atmospheric variations, such as humidity and pressure change, affect the resistance only to the extent that they vary the rate at which heat is dissipated from the thermistor. The user must be sure that only ambient temperature variations are controlling the resistance of the thermistor and self-heating must be kept below a permissible tolerance, or compensated in calibration.

The properties of thermistors related to the resistance variations caused by self-heating have led to the use of the components as switching devices, regulators, time delays and other sensing and control means. Current flow in a thermistor establishes two relationships based upon the resistance change in the element due to self-heating. The first, current versus voltage, is a static or steady state condition. The second, current versus time, is a dynamic relationship based upon the fact that the resistance variations resulting from self-heating are not instantaneous.

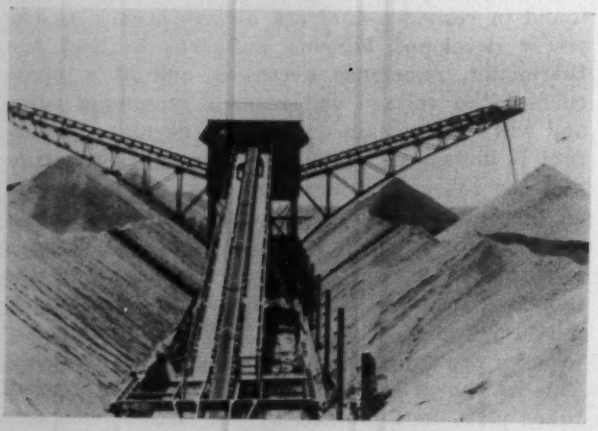
In considering the static characteristics, the usual linear relationship of current versus voltage found in resistors does not always exist. As the power developed becomes sufficient to heat the thermistor, resistance decreases and at a given current the voltage will reach a maximum value and will then remain constant or decrease as current is increased, *Fig.* 2. The dynamic properties must be considered, however, as a certain interval of time elapses before the equilibrium current of a thermistor circuit is attained. After a voltage is applied, the initial current is determined by the unheated resistance of the element. As the thermistor becomes heated due to the internal power loss, its resistance decreases and current increases. This is shown in *Fig.* 3. A build-up of current takes place until limited by the circuit resistance which may be augmented by a series resistance to hold operations below the maximum recommended temperature.

Application of thermistors has advanced in recent years but similar to advances by other semiconductors, the present stage of development could be considered still in the pioneering stage. However, expanded use of the thermistor is solidifying its position as a standard component in the design and fabrication of electrical, electromechanical and electronic equipment.

HEAVY DUTY CONVEYING PROVES VALUE OF ANTIFRICTION BEARINGS

SINCE its establishment 26 years ago, the Port Inland plant of the Inland Lime & Stone Co. has shipped 70 million tons of quarry stone. Conveying and handling equipment which serves this large stone plant operation was originally engineered and, through the years, has been added to by the Stephens-Adamson Mfg. Co. The system is notable for the design features it contains—features which have become accepted practices in the quarry industry.

Rock is brought to the crusher building by rail from a quarry. Four belt conveyors move rock from the crusher building to large traveling stackers which discharge to desired storage piles. The stackers, 60 feet high, raise the main belt on a long inclined carriage for discharge to boom conveyor belts which convey at right angles to the storage piles. The 60-foot long sloping boom belts are capable of stacking rock up to a height of 80 feet.



For reclaiming and shipping, concrete tunnels run under the storage piles and are equipped with gravity type loading gates located at 20-foot intervals. The gates are winch-operated and swing into position so that material is discharged onto the belt in the direction of belt travel. Belts in the reclaiming tunnels run along the long axis of the piles to a lateral belt which runs underground to the ship and rail loading station. Present facilities make it possible to process up to 1000 tons of stone an hour and to load on ships or trains at the rate of 3000 tons an hour.

One of the original innovations, considered revolutionary at the time, was the use of antifriction bearings in the belt conveyor carriers. In the last 10 years, the 22,500 roller bearings in the carriers have had a failure record of only 0.0057 per cent. This low failure rate has been an important factor in the elimination of shutdown time and improved savings in maintenance costs; the use of antifriction bearings is today an accepted feature of stone plant design.

The individual drive motors for the conveyor system are connected in sequence for proper starting and provide for a 30-second time lag in the starting of each unit to prevent jamming at any point in the interlocking system. The electrical controls are located on a central control board. They provide that the farthest removed conveyor in the desired path starts first and units leading to it start up in opposite sequence to stone travel. A total lag of 5 to 6 minutes is necessary to get operations underway. Should any conveyor or sizing unit stop along the line, all units feeding to it stop automatically and cannot be started until the difficulty is eliminated.

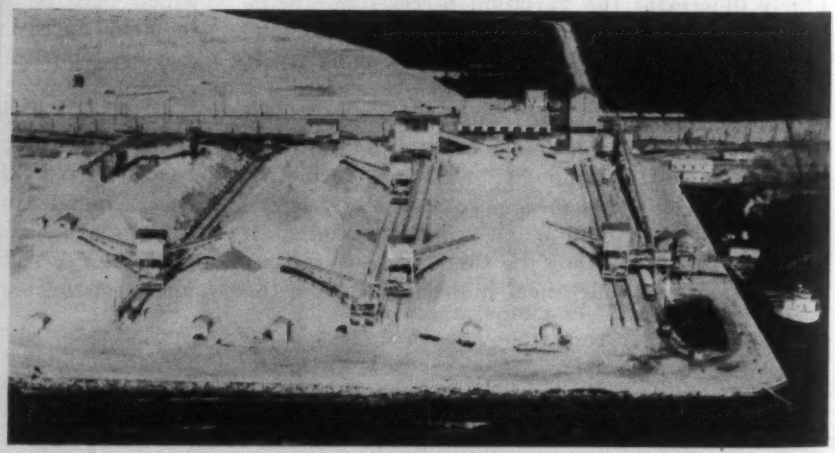


Fig. 1—Aerial view of crushed stone plant shows array of conveying and stacking equipment. Movable stacker tower permits piling of stone to 80-foot heights. Twenty-six years ago these belt conveyor carriers were among first applications of antifriction bearings to quarry operations. Most of the original bearings are still in use.

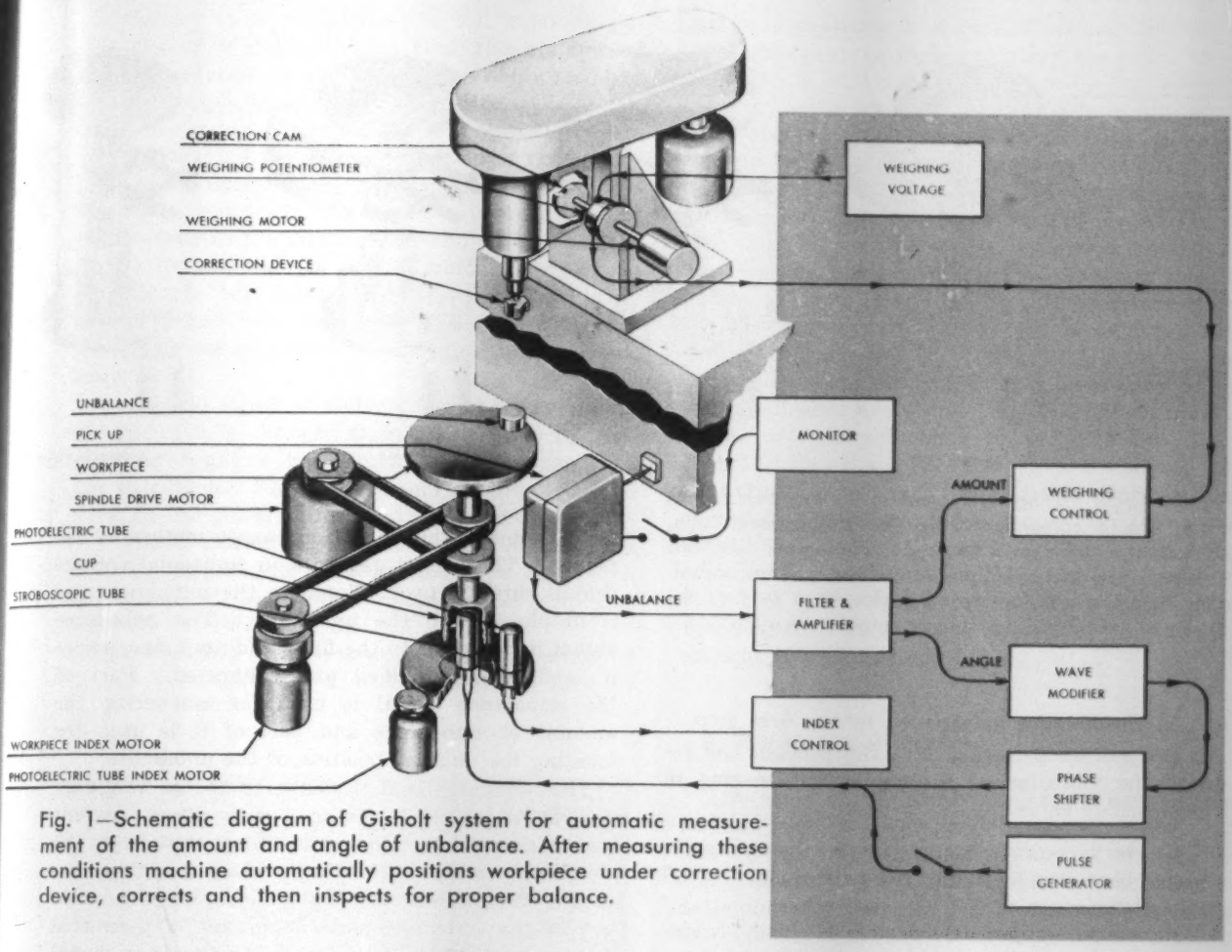


Fig. 1—Schematic diagram of Gisholt system for automatic measurement of the amount and angle of unbalance. After measuring these conditions machine automatically positions workpiece under correction device, corrects and then inspects for proper balance.

AUTOMATIC BALANCING

CORRECTS AND INSPECTS

By **CLIFFORD LANDSNESS**
Supervisor—Balancing Engineering
Gisholt Machine Co.
Madison, Wis.

Processing engineers are looking for methods of performing all sorts of operations automatically. Here automatic measurement of unbalance is combined with automatic correction and inspection on machines that handle the workpieces through these operations, in co-ordination with other equipment in the automated production process.

INDUSTRY'S DEMANDS for higher production at a lower cost and more uniform and better product have brought about the automatic operation of many processes, including balancing. The elimination of unbalance in rotating parts is of prime importance today, both to meet engineering requirements for acceptable performance, and to satisfy sales demand for an improved product.

Balancing is a process whereby the distribution of mass in a rotating body is altered to eliminate vibration at the supporting bearings. The balancing process is normally done in three steps.

1. Measurement of the amount and the angular location of the unbalance.

2. Alteration of the workpiece at the location

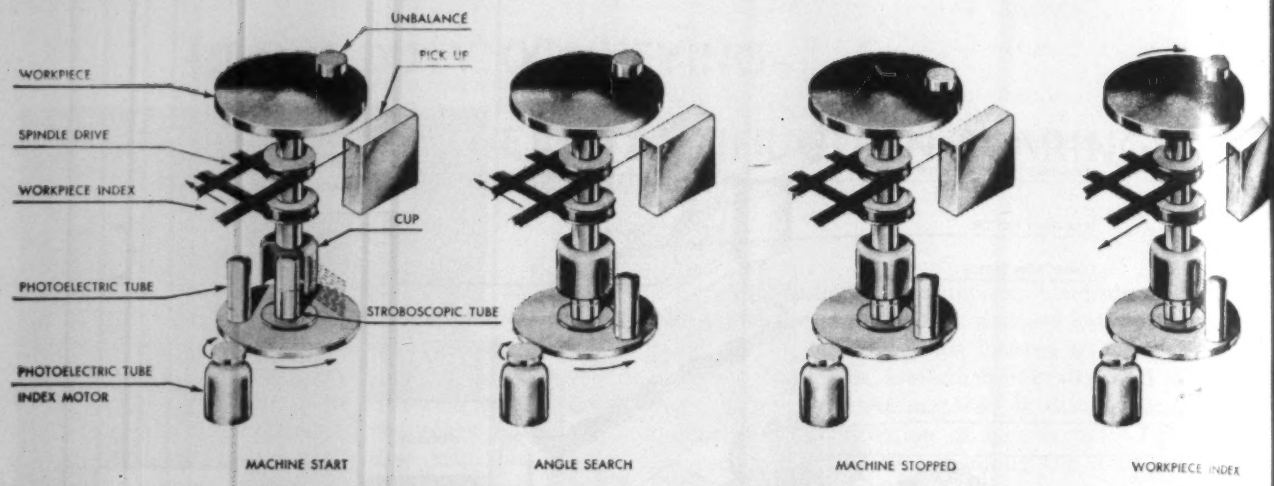


Fig. 2—Angle finding equipment in various parts of its cycle. Main components are the stroboscopic tube, photoelectric tube and the cup. Equipment functions to search for and mark position where rotating unbalance is in line with correction device, then indexes the stopped workpiece back to that angular location.

and in the amount determined by the first step.

3. Inspection to insure that the process has reduced the vibration at the supporting bearing to a permissible value.

Only very recently has a completely automatic process been developed for the performance of all of the above steps.

Balancing equipment, developed and trademarked Dyn-Aut-RoniC by the Gisholt Machine Co., will do the complete balancing process without an operator. The basic method of doing the previously mentioned steps can be explained by referring to a simplified version of this balancing equipment, *Fig.* 1.

▶ Unbalance Measurement

Unbalance in the flexibly mounted workpiece causes it to vibrate when rotated by the spindle drive motor. This vibration causes motion of the pickup. The pickup generates a sinusoidal voltage that is directly proportional to the unbalance and is in phase with the unbalance. The unbalance signal is delivered to the filter and amplifier, where it is filtered, amplified and calibrated. Part of the unbalance signal is used for measuring the amount of unbalance and part of it is used for locating the angular position of the unbalance.

The amount signal is delivered to the weighing control where it is changed into direct current and used to drive the meter relay that is in the weighing control. The meter relay has two contacts, one set at zero unbalance and the other set at the unbalance tolerance that is permitted for a particular workpiece. If the amount signal does not close the tolerance contact on the meter relay, the part is within its balancing tolerance and no correction is called for. If the amount signal closes the tolerance contact, it will start the weighing motor on the weighing potentiometer. The weighing potentiometer delivers a voltage of opposite potential to the meter relay, bucking out the voltage from the amount signal. When the current flow in the meter relay is zero, the zero contact closes which stops the weighing motor.

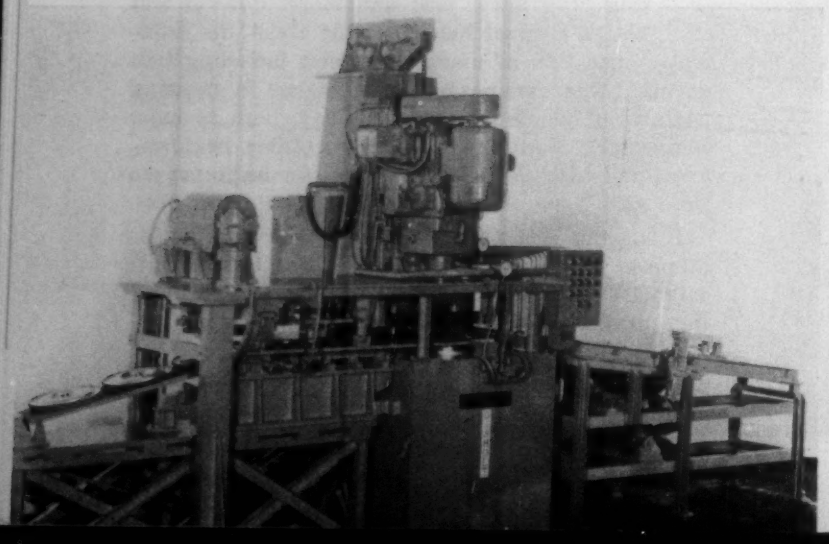


Fig. 3—Single station vertical balancing machine for completely automatic measurement, location, correction and inspection; equipped with handling equipment to load and unload the work station; tooled to balance automotive flywheels.

Weighing voltage delivered to the weighing potentiometer is calibrated so that the amount of angular rotation of the weighing potentiometer is directly proportional to the unbalance. Connected to the weighing potentiometer is a suitable means for transferring the angular rotation of the weighing potentiometer into the amount of unbalance correction required. Shown is a correction cam which controls the depth of the end mill. The cam fall at the angular position to which the cam was turned sets the depth of cut required to bring the workpiece into balance. This completes the automatic measurement of the amount of unbalance.

The angle signal is delivered to the wave modifier where it is changed from a sine wave to positive and negative pulses that are in phase with the unbalance. The angle signal is then delivered through the phase shifter to the stroboscopic tube. The phase shifter adjusts the angle signal such that it triggers the stroboscopic tube once each revolution, at the time the unbalance is in line with the correction device.

The cup over the stroboscopic tube is attached to the work spindle. The cup has a slit in it to allow the light from the stroboscopic tube to pass through in a narrow band. For any given workpiece that is mounted to the spindle the angular relationship between the unbalance and the slit in the cup remains constant. While the spindle and cup are revolving the photoelectric tube motor is energized and causes the photoelectric tube to rotate around the cup in search of the position of the slit at the time the stroboscopic tube flashes, *Fig. 2—machine start.*

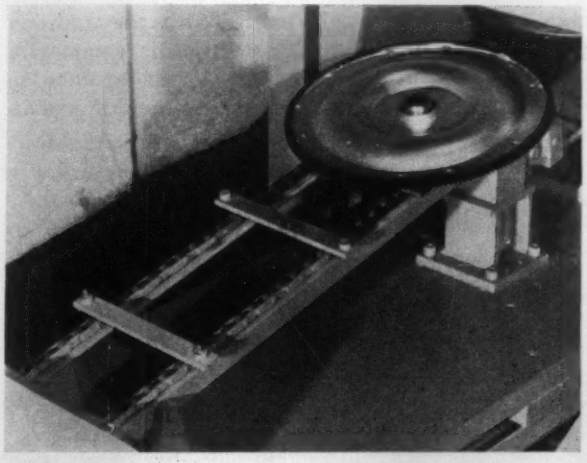


Fig. 4—Incoming conveyor has a pair of crossbars to support each workpiece. One bar has two pins to fit bolt holes and establish proper angular position for loading station. Other bar has rest buttons only.

As soon as the photoelectric tube is energized by receiving flashes through the slit in the cup, the signal goes to the index control where it is amplified and stops the photoelectric tube index motor, *Fig. 2—angle search.* This position of the photoelectric tube serves to mark the place where the spindle is when the unbalance is in line with the correction device. The workspindle rotation is then stopped. The spindle comes to a halt at a random angular position with respect to the photoelectric tube, *Fig. 2—machine stopped.*

In order that the correction of unbalance in this example may be made by removing metal from the position of unbalance, it is necessary now to rotate the spindle around to the position marked by the photoelectric tube. The workpiece index motor is energized to cause this rotation and the pulse generator triggers the stroboscopic tube so that flashes are visible from the slit as the cup turns. As the slit comes in line with the photoelectric tube, this tube picks up the flashing and its output is delivered to the index control which stops the workpiece index motor, *Fig. 2—workpiece index.* This is the position of the workspindle where the unbalance area of the workpiece is in line with the correction device, so the automatic cycle for finding angular location of the unbalance is completed.

Workpiece Alteration

Alteration of the workpiece at the location and by the amount determined in the first step can now be done. It is usually done by varying the depth of correction or the length of correction as determined by the cam fall at the angle to which the cam was indexed by the weighing drive motor. As shown in *Fig. 1* the automatic correction device comes in, removing metal from the work-

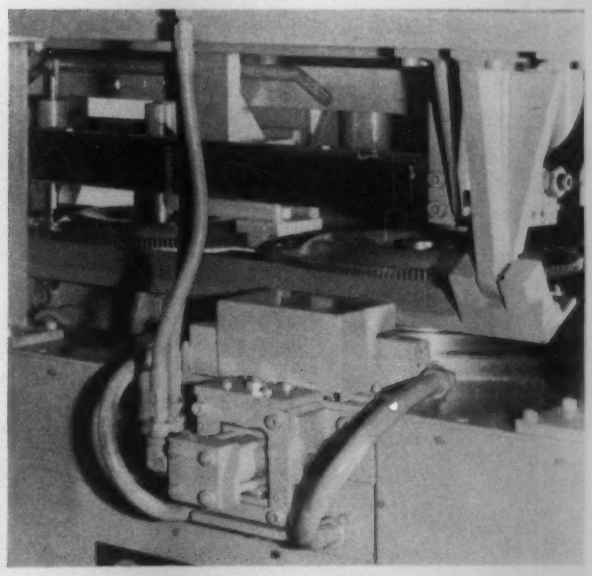


Fig. 5—Close view of lifting rail carrier. Flywheel at left is above loading station, with prepositioned locations maintained by a cup over center hub and a pin in a bolt hole. Flywheel at right has been balanced. Carrier will move to right taking one workpiece to unload station and the other to the workspindle.

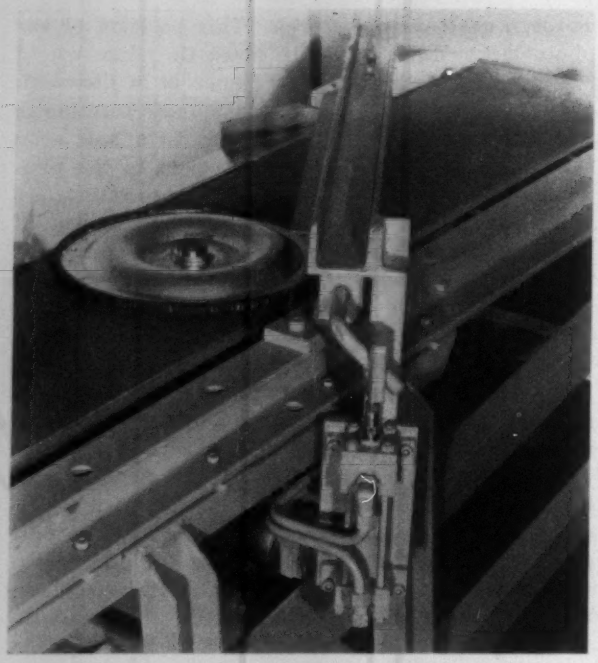


Fig. 6—Reject gate on outgoing belt conveyor swings down to divert flywheels that have not passed inspection.

piece until the depth control device touches the cam, giving the proper correction to the workpiece.

Unbalance Inspection

Inspection of the unbalance is performed in the same way as the amount measuring except that the meter relay in the weighing control receives no bucking voltage from the weighing potentiometer. Also the angle of the unbalance left in the workpiece is not determined. If the unbalance in the workpiece has been reduced to within the tolerance desired the meter relay tolerance contact does not close and the part is in balance. If the unbalance in the workpiece is over the tolerance desired the meter relay tolerance contact closes, giving a signal that can be used to reject the workpiece or to mark the workpiece as a reject.

Inspection controls are monitored to insure that they are operating satisfactorily. This is done by the monitor shown in *Fig.* 1. The monitor, first, gives the pickup a motion that corresponds to slightly more than the balancing tolerance, and second, gives the pickup a motion that corresponds to slightly less than the balancing tolerance. The pickup output is delivered through the filter and amplifier to the weighing control where it is used to drive the meter relay (same as in the inspection cycle). The first output from the pickup must close the meter relay tolerance contact. The second output from the pickup must open the meter relay zero contact but must not close the meter relay tolerance contact. If this full sequence fails to happen the machine shuts itself off.

The development of this balancing process brings about innumerable possibilities for the design of balancing equipment. With the addition of automatic handling, the machine is completely automated. Automatic balancing can be done at one station or the process may be divided among several stations.

Flywheel Balancing

Shown in *Fig.* 3 is a single station vertical balancing machine which has automatic handling.

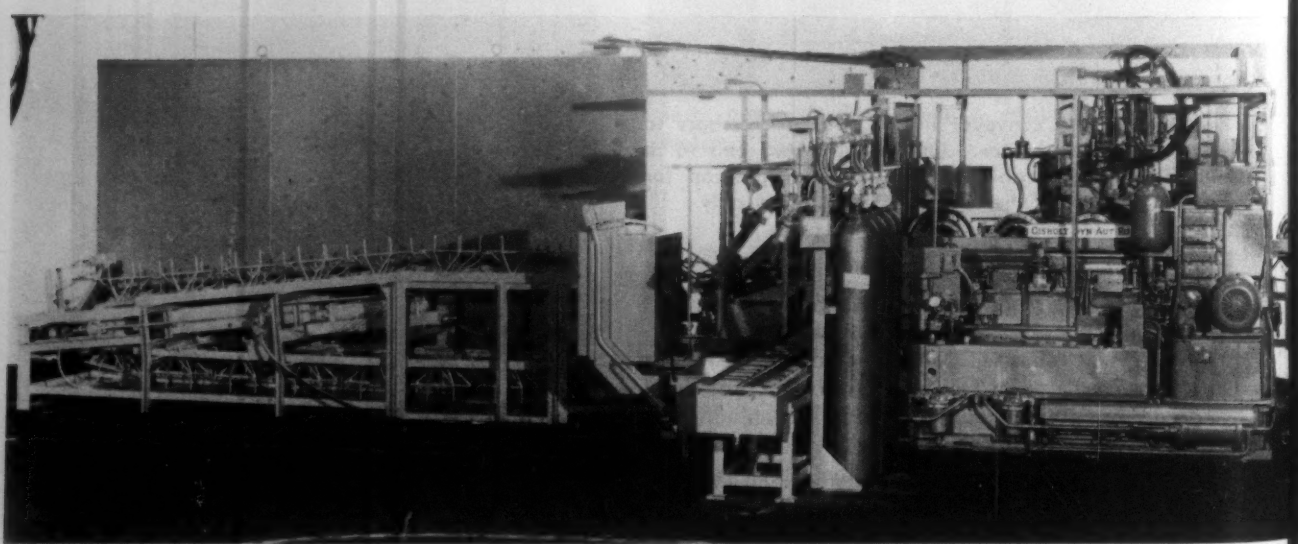


Fig. 7—Multistation horizontal balancer that automatically measures unbalance of an automatic transmission torus case, welds on a correction strip, inspects balance with the assembly full of oil, disassembles, washes, rinses, and drys the units. Balancing steps which are performed in one station on the machine shown in *Fig.* 3 are here divided up into three stations.

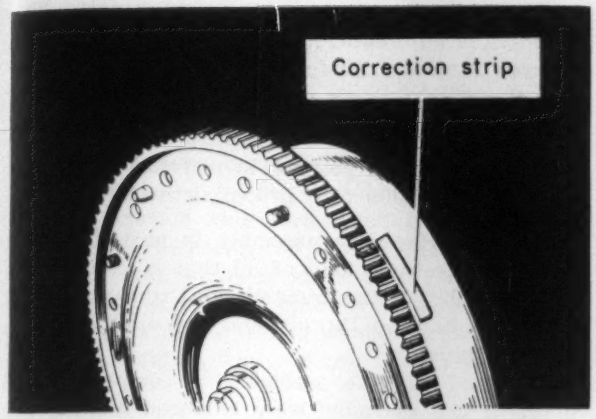


Fig. 8—Sketch of the workpiece handled by the machine shown in *Fig.* 7. Two major parts are the flywheel and the torus cover.

The workpiece is a pressed steel flywheel that is a part of an automatic transmission for an automobile. At this point in the manufacturing process the flywheel has an inherent unbalance due to the uneven spacing of the bolt holes. The balancing arbor or spindle has an amount of unbalance in it to counter the inherent unbalance in the flywheel. After the balancing operation is completed, additional bolt holes are added, making the bolt holes in the flywheel symmetrical to eliminate this inherent unbalance.

Uneven spacing of the bolt holes provides a means for presenting the flywheel to the balancer in a known angular position. When the flywheel is oriented on the balancer spindle, the spindle's unbalance is introduced in the flywheel in the proper angular location. The projecting hub of the flywheel provides a means for transferring the flywheel from the load station to the balancing station. During the balancing operation the flywheel is located from a bored hole in its hub and is driven by a pin through a bolt hole.

The incoming conveyor, *Fig.* 3, is loaded by the man on the previous operation. This conveyor is of the chain type with pairs of bars on which the flywheels are supported. One of the pairs of bars has two pins which locate the angular position of the flywheel, *Fig.* 4. This conveyor is moved by means of a hydraulic cylinder which advances the flywheel step by step until it arrives at the loading station. The incoming conveyor will keep advancing until a part is delivered to the loading station and then will wait until the transfer has moved the part from that station.

The transfer is cam driven and consists of a cup that fits the protruding flywheel hub, of a pin which goes into a bolt hole, and of two lifting rails which raise the flywheel off of the incoming conveyor and also raise the completed flywheel off the balancing spindle. Shown in *Fig.* 5 is the transfer at the loading station with the flywheel engaged by the pin and cup, raised and ready to move toward the balancing spindle. When the transfer moves to the right, the flywheel at the balancing spindle is simultaneously moved to the unload conveyor. The transfer carries the incoming flywheel to the balancer spindle which has been stopped at the proper index for loading.

The flywheel is located on the balancing spindle by expanding a collet in the bore of the flywheel hub and driven by means of a pin through a bolt hole. The flywheel is rotated at 1000 rpm and the unbalance is simultaneously measured and located. If the unbalance in the flywheel is within tolerance, it is transferred on. If the flywheel is over tolerance the amount and location of unbalance are determined and the flywheel is stopped and indexed to bring the heavy spot under the correction device.

Correction is made by sinking a two inch diameter end mill to a depth determined by the depth cam in the milling head, which was set by the unbalance measuring cycle. The flywheel is clamped between parallel plates during milling and chips are removed by a suction device.

Upon completion of the correcting milling operation, the balancer spindle is rotated while inspection for accuracy of balance is made. After completion of inspection, the spindle is stopped and indexed to a position to receive the next flywheel from the loading station. The flywheel is lifted off the balancer spindle by the rails and the transfer pushes the finished flywheel to the outgoing belt conveyor. The outgoing belt conveyor delivers the flywheel to a desired location. If the flywheel did not pass inspection, the reject gate, *Fig.* 6, swings down and diverts the flywheel from the belt conveyor. While the transfer device is

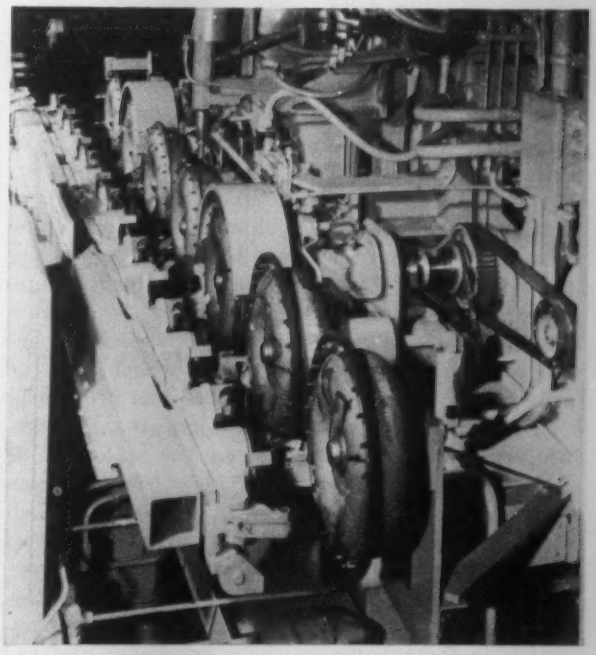


Fig. 9—View of machine from incoming end shows parts in stations: 1. Load, 2. oil fill, 3. unbalance measure, 4. correction, 5. idle, 6. inspection, 7. remove nuts or reject, 8. disassemble. Transfer bar moves each workpiece to the next station simultaneously.

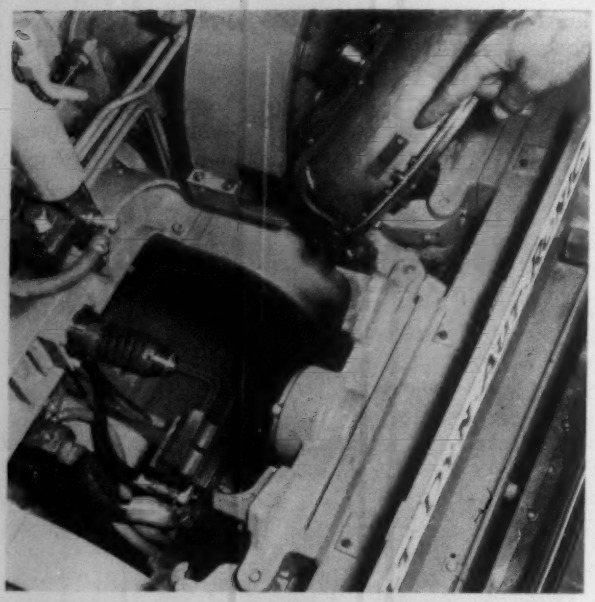


Fig. 10—Correction strip is spot welded by opposing electrodes one at the top and one at the bottom of the workpiece. Lower electrode has fingers which hold the correction strip until it is welded onto the workpiece.

operating, the accuracy of the inspection equipment is monitored.

Balancing tolerance is ¼ ounce-inch. Production rate is 150 parts per hour if maximum correction is required on each part and is 250 per hour if all parts are received within tolerance. The machine's efficiency exceeds 95 per cent.

▶ Integrating Balancing

Where circumstances require, other operations in addition to balancing can be incorporated as part of the balancing machine's automated cycle. This enables automatic balancing operations to be a more completely integrated part of the production line. An example of such equipment is a multi-station horizontal balancer, *Fig.* 7, which performs several other functions after balancing the workpiece. The workpiece, *Fig.* 8, is a subassembly of the torus enclosure for an automotive automatic transmission. The assembly consists of two major parts, the flywheel and the torus cover. The flywheel member has previously been balanced as an individual component, therefore, correction for balance in the assembly is made on the torus cover. These two members are accurately positioned with respect to each other by dowel pins. An O-ring between the two members prevents oil leakage during balancing even though only four nuts hold the members together. Location of the assembly during the balancing operation is from bores in the torus cover and the flywheel. The correction is made by spot welding, and because there is a remote possibility of fire due to the oil in the assembly at the time of welding, the complete machine is protected by an automatic carbon dioxide fire extinguishing unit. The assembly is automatically transferred by means of a seven station transfer bar which is shown in *Fig.* 9. The following is a description of the stations.

Load. The load position shown corresponds to the unload position of a preceding transfer line.

Oil Fill. Here the assembly is partially filled with oil (the same kind of oil that is used in the final assembly of the transmission) to a point just below the hub, so the oil does not spill out during the transfer.

In actual use the assembly is completely full of oil. If the assembly were balanced without oil, an unbalance would be introduced when the assembly was filled with oil because of the eccentricity of the unmachined cavity with respect to its rotational axis.

Unbalance Measure. At this station the assembly is located on an expanding arbor which centralizes the assembly on its locating surfaces within a total indicator reading of 0.0002 inch. The arbor is expanded with oil pressure. At the same time the oil pressure forces out two floating serrated jaws which drive the assembly. The assembly is rotated at 1200 rpm. The amount and location of unbalance are simultaneously determined. The assembly is stopped and indexed to bring it in position for application of correction at the next station.

Correction. Correction is applied by spot welding onto the periphery of the assembly a length of 15 gauge strip, ⅝ inches wide. The length may vary from a minimum of ½ inch to a maximum of 7.8 inches depending on the amount of unbalance correction required. The correct length of strip is determined from the cam that was set by the unbalance measuring station. The length of the strip is not proportional to the amount of correction required because the center of gravity of the curved strip changes with its length, therefore, a cam is used which accounts for the center of

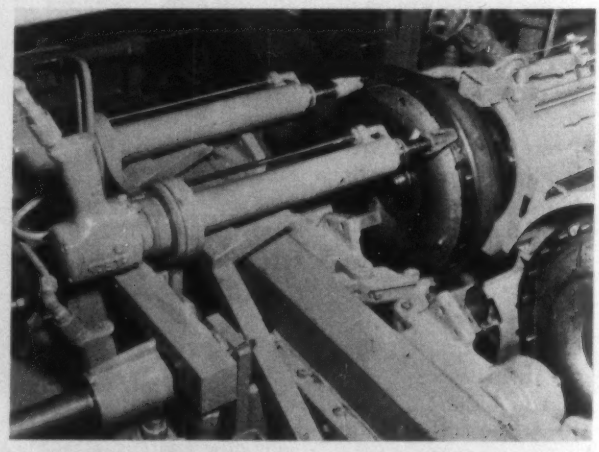


Fig. 11—Those assemblies that pass the balance inspection have the four nuts removed by pneumatic wrenches that retract and drop nuts into chutes.

gravity as well as the length of strip, giving a true correction for unbalance. The correction strip is unrolled from a reel, straightened, formed to an arc corresponding to the radius of the assembly, cut to length and transferred to the welding gun. All this happens during the time the assembly is being indexed to the correction angle at the previous station and during the transfer of the assembly to the correction station. The position of the correction strip is such that the center of gravity of the strip is in the center of the welding fingers. When the assembly arrives at the correction station, the welding gun is waiting to weld the correction strip onto the piece, *Fig.* 10.

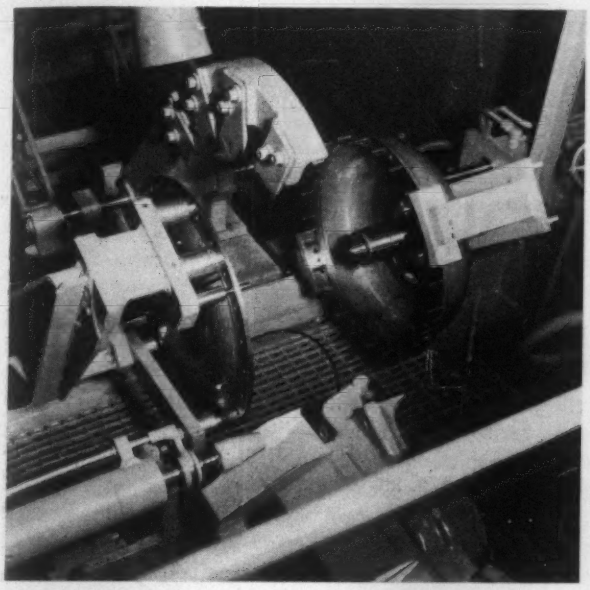


Fig. 12—Workpiece is split apart and O-ring removed before parts are transferred to washer baskets. The O-rings are conveyed to a cart where they are collected for re-use.

The welding gun makes one spot weld on correction strips under 1 inch in length and three spot welds on strips over 1 inch in length. The first spot weld is at the center of the strip and the other two spot welds are ¼ of an inch from each end of the strip. This is done to prevent the strip from peeling off under the high rotational speeds experienced in the automobile.

Idle. The machine contains an idle station between the correction and inspection stations because of the substantial proportions of the welding equipment.

Inspection. The assembly is located at the inspection station in the same way as at the unbalance measuring station. From the start of acceleration until three seconds after the asembly reaches balancing speed, the cavity in the assembly is being pumped completely full of oil. Addition of oil at this station duplicates the conditions under which the assembly operates in the automobile. The assembly is now inspected for balance, insuring that the unbalance has been reduced to less than ½ ounce-inch. The assembly is then stopped and rotated to give the proper index to the four nuts holding the parts together.

During transfer of the assembly, the inspection station is monitored to insure that it is operating satisfactorily.

Remove Nuts or Rejects. If the unbalance in the assembly, which was determined by the inspection station, is over ½ ounce-inch it is gripped by an electromagnet which pivots down and sets the assembly, hub up, on the reject conveyor. The reject conveyor is of the roller type letting gravity transfer the assembly to a salvage area for reworking.

If the assembly is within balancing tolerance, four air wrenches advance, *Fig.* 11, and remove the nuts which hold the parts together. After removal, the nuts are dropped into chutes which deliver them to a container so they can be reused.

Disassemble, Drain and Transfer to Washer. The flywheel splitting arm advances carrying two pins which go through holes in the flywheel and push the torus cover back away from the flywheel, separating the two pieces. The flywheel is restricted from moving at this time. Four permanent magnets on the flywheel splitting arm contact the flywheel and when the arm retracts they pull the flywheel off the arbor. The flywheel is now carried on two pins as shown in *Fig.* 12. A hook-like member carrying four blades is cammed in by the retract motion of the flywheel splitting arm and separates the O-ring from the flywheel. The O-rings fall on a conveyor which carries them to a cart outside of the machine so they can be reused. The oil from the assembly is returned to storage for reuse in succeeding assemblies.

The two arms rotate over and set the parts into the basket-like members of the washer conveyor.

Wash, Rinse and Dry. The basket-like members pass through the wash, rinse, and blow-off sections of the washer. The parts are carried together in pairs and are finally delivered to the assembly lines.

This balancer produces parts at the rate of 180 per hour. The efficiency of the machine is in excess of 95 per cent.

▶ Balancing Trends

The type of operations described in this article reflect the trends of industry toward automatic handling of workpieces and automatic machine setting and control to accomplish the requirements of the production process. With the development of this complete balancing system another operation takes its place in the array of techniques from which automated manufacturing lines are devised. It is a logical step for manufacturers to upgrade their balancing operations to keep pace with their overall automation programs.

TABLE 1
pH Classifications

pH	Solution description
0	Very strongly acid
1	
2	Strongly acid
3	
4	Slightly acid
5	
6	
7	Neutral range
8	
9	Slightly alkaline
10	
11	Strongly alkaline
12	
13	Very strongly alkaline
14	

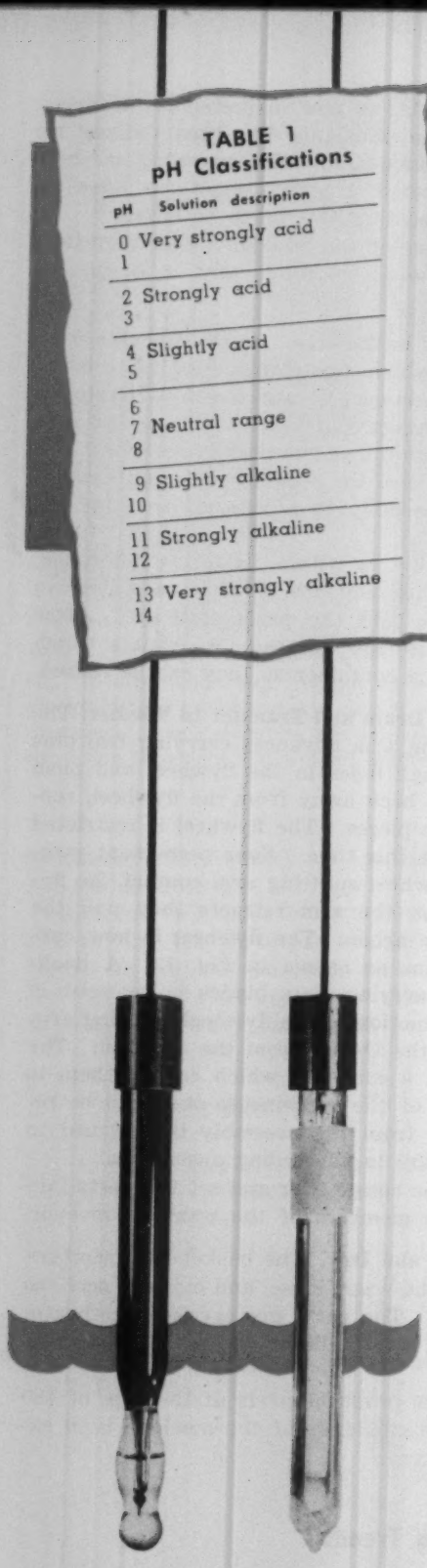


Fig. 1—Electrode pair used in measurement of hydrogen ion concentration in a solution *(l)* illustrates a glass electrode containing a platinum lead immersed in a reference solution inside the glass tube. The potential between the solutions inside and outside the tube indicates the pH of the process solution *(r)* shows the calomel electrode used to complete the circuit through the solution being tested.

Acidity or alkalinity of a process water or solution is a variable important in some phase of nearly all industries. Control or lack of control of this variable can affect operations ranging from simple heating tasks to sensitive product formulation. Measuring, recording, and controlling of pH values may be performed completely automatically as pointed out in this article.

CONTROLLING pH OF PROCESS SOLUTIONS

By J. B. MOHLER, Consulting Engineer

REFINEMENTS IN CONTROL of a process variable usually progress through the steps of discovery, measurement, manual control, recording and automatic control. Handling of many variables does not advance beyond the measurement stage because of difficulties in isolating or sensing them, but time-tested methods for measuring acidity or alkalinity of solutions have resulted in many industrial installations for precise control of this fundamental process variable. Practical applications of such measurement and control can be found throughout industry for many chemical process steps, such as neutralization, precipitation, coagulation and fermentation. Measurement is also useful for the control of the stability of emulsions and protection against corrosion as well as in direct control of solutions such as electroplating baths, dyes, colloidal solutions and treated effluents returned to public streams and sewers. Automatic control of this variable is also used for: Clarification in cane sugar mills by control of limed juice, addition of reagent during the manufacture of paper stock, neutralization of corrosive process feed waters, neutralization for floc formation in filter plants, controlled liming in lime softening filtration plants, neutralization of absorbed carbon dioxide and sulfur dioxide in spray ponds, and neutralization of treated boiler feed waters.

Since acidity or alkalinity is a reflection of the hydrogen ion concentration in the solution, this condition can be described by a pH rating which is the negative logarithm of the

Mr. Mohler is now associated with the Kaiser Aluminum & Chemical Corp., Spokane, Wash. in the Department of Metallurgical Research.

hydrogen ion concentration in gram atoms per liter. Thus a pH of seven, which is neutral, means a concentration of 10^{-7} or 0.0000001. An acidic solution, having a greater concentration of hydrogen ions than a neutral solution, will have a pH rating of less then seven. Pure water has a neutral pH value of 7. The addition of acid or alkaline chemicals to water causes a change in pH and produces solutions that can be roughly classified as shown in TABLE 1. It will be noticed that the pH range from slightly acid to slightly alkaline is quite broad. Thus in this range a small addition of strong acids or alkalis will cause quite a large change in pH. At the extremes of the scale, large additions of chemicals cause much smaller changes in pH.

Hydrogen ion concentration is measured by an operator observing sensitive dye reactions where close pH control is not required. For greater accuracy, or to take advantage of instrumentation, the electrometric method is used. By the use of the proper electrodes pH can be measured as a voltage and the voltage may be translated directly into pH units. The glass electrode is almost universally used for pH measurement. This electrode, *Fig.* 1 (*l*), consists of a platinum wire immersed in a reference solution inside a glass tube. The voltage that can be expressed as pH is the difference in potential between the solutions inside and outside the glass tube. A standard calomel electrode, *Fig.* 1 (*r*), is used to complete the circuit. Measuring means amplify the weak potential across the glass electrode and balance the circuit against a standard voltage. After the circuit is balanced the pH may be read from a potentiometer circuit by means of a null point galvanometer or it may be read from a calibrated ammeter. The amplified voltage can be picked up by a recording unit or a recording and controlling device. If a controlling potentiometer is used, any condition of unbalance can be made to actuate solenoid valves for control purposes.

By means of valves which are so controlled, chemicals can be added to adjust pH values. In almost all processes the pH will tend to change only in one direction, thus a single acid or alkali can be used to control most process pH values. However, provision can be made to add acid for a deviation in one direction and alkali for deviations in the opposite direction.

Control of pH to 0.1 unit is relatively easy with modern instruments. This represents a very small chemical change and is usually satisfactory for industrial purposes, however reproducibility to 0.01 unit is possible. The fundamental problem is to determine the importance of pH control and to decide on the range to be held. In most processing solutions such as dyes, tanning solutions and plating baths, the pH is relatively stable. Consequently, manual measurement and adjustment will often suffice since such measurements may only be required several times a week. If the solutions are put to continuous hard use or if they tend to change readily, then automatic recording or automatic control may be indicated.

▶ Components and Systems

Other types and combinations of electrodes are used, but the glass-calomel pair, *Fig.* 1, is the

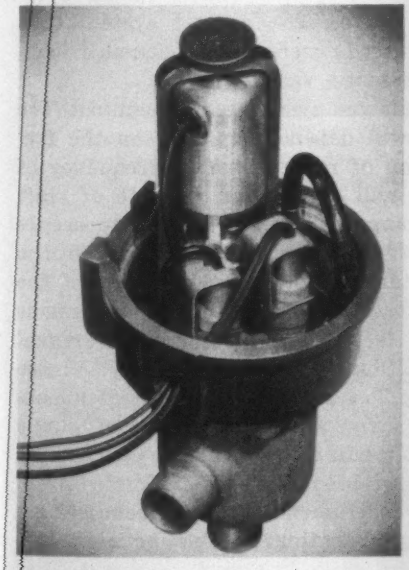


Fig. 2—Since pH level in a given solution varies with temperature, this unit for checking pH of solution flowing in a pipe includes a resistance thermometer to correct for voltage change due to temperature.

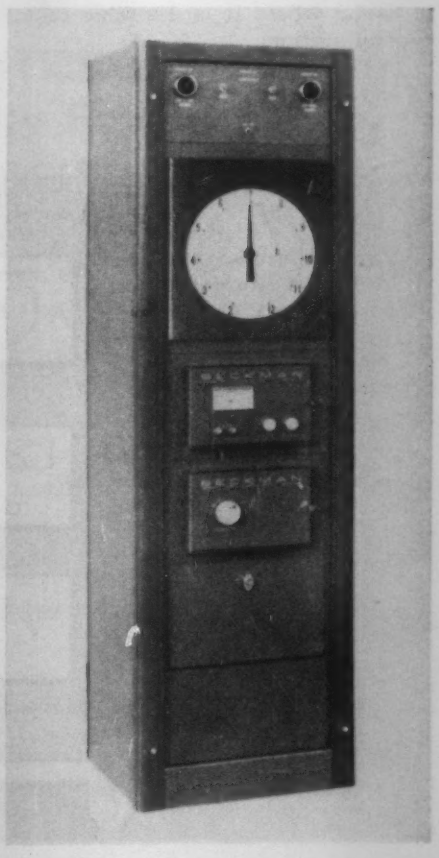


Fig. 3—Commercially available packaged units such as this amplify the weak potential from the electrodes, record the pH level represented, and adjust metering devices to control addition of corrective chemicals.

most common. Since pH for a given solution changes with temperature some correction must be made for accurate measurement. This correction can be manually applied to a measuring instrument or it can be automatically applied. A resistance thermometer inserted in the solution can be used to correct for the voltage change with temperature. A sensing assembly for checking pH of a solution flowing in a pipe, with automatic correction for temperature, is shown in *Fig.* 2. This assembly contains an electrode pair and a resistance thermometer and provides a means for measurement of solutions being processed.

An indicating, recording and controlling unit is shown in *Fig.* 3. This unit contains an ac operated electronic amplifier. It can be used for direct reading of pH, and feeds the amplified current to a standard recording and controlling potentiometer. Since the current generated by the pH cell for an off-balance condition is very weak, it is necessary to shield instruments and leads to avoid the effects of stray currents. Proper shielding is provided with the leads and instruments; and industrial equipment is manufactured for convenient connections without the necessity for splicing, which would interfere with the shielding.

An automatic multiple switch is available for monitoring of a number of stations so that pH may be read for a number of points in the plant, *Fig.* 4. If a multiple point potentiometer is included in the circuit then pH may be recorded or controlled for several locations. The multiple point recording-controlling potentiometer can also be used for temperature measurement by the use of thermocouples. Such multiple function equipment is useful where it is desirable to install a central control station.

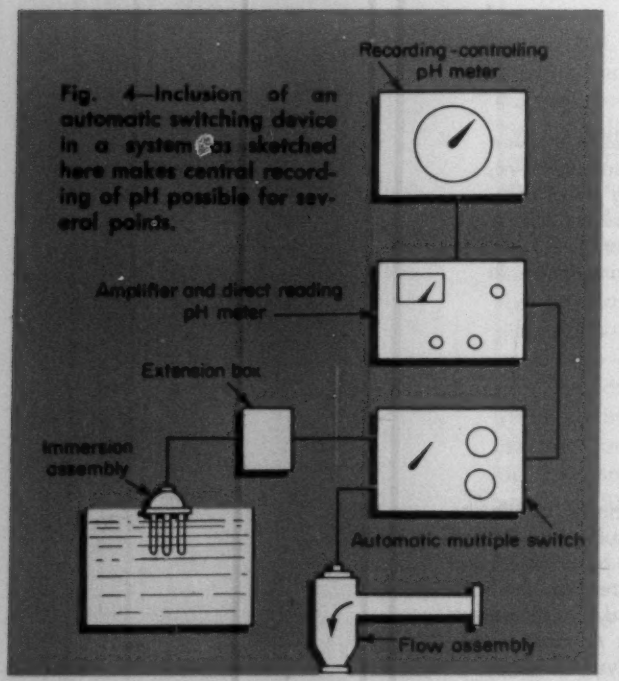


Fig. 4—Inclusion of an automatic switching device in a system as sketched here makes central recording of pH possible for several points.

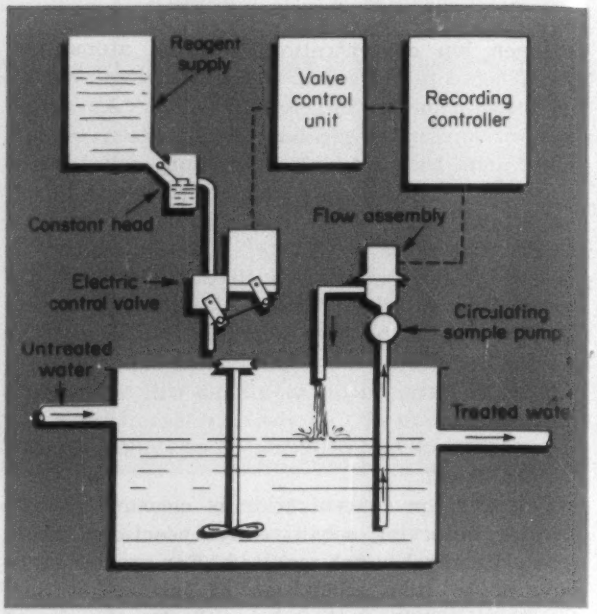


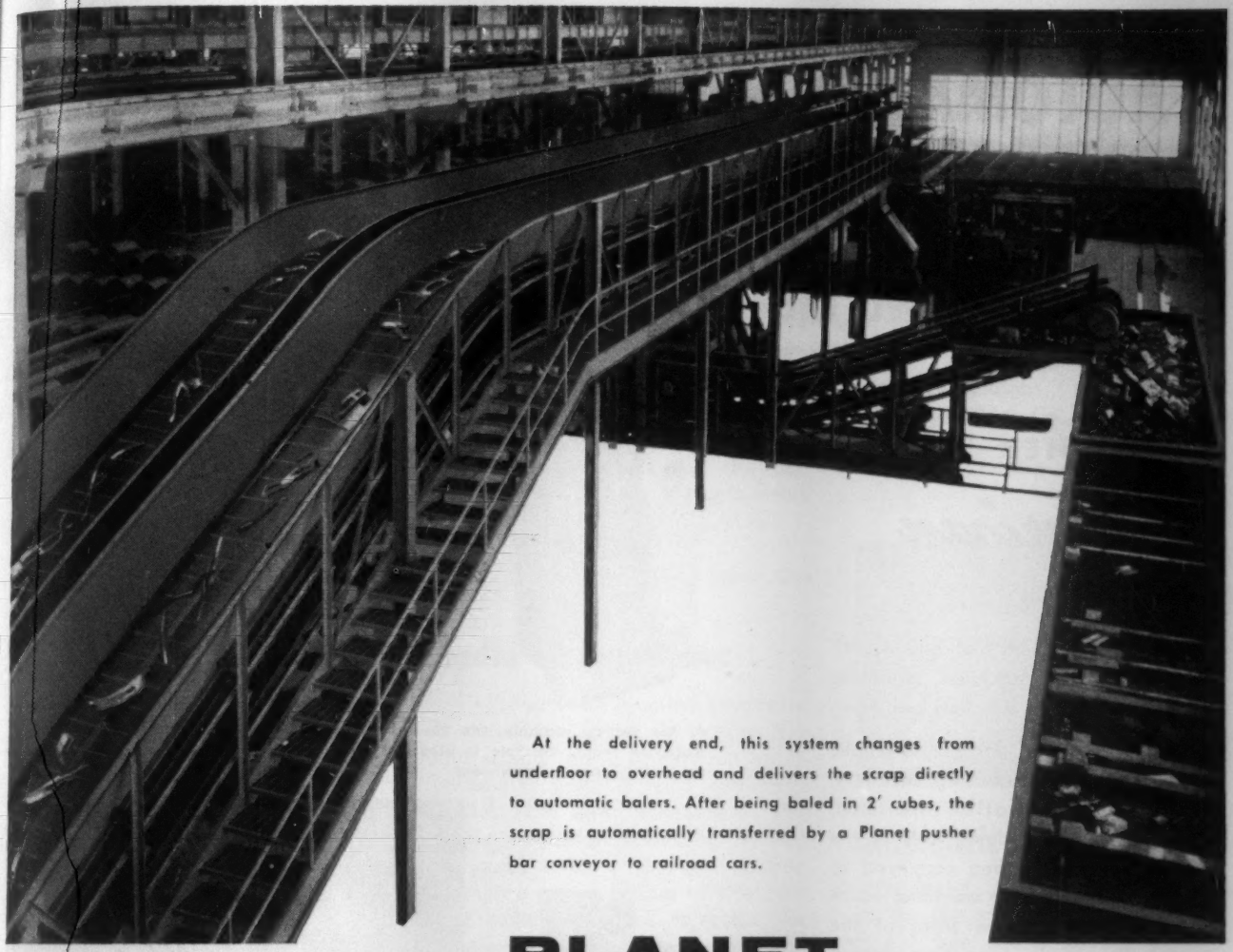
Fig. 5—Where addition of a single reagent will control solution pH, an installation of this type can automatically adjust reagent flow to obtain desired pH levels.

A typical installation used for treatment of process water is shown in *Fig.* 5. The controlling potentiometer adjusts the control valve by means of the valve control unit in response to the voltage from the sensing head. By the use of this system throttling control is possible since the pH level can be used to increase or decrease the flow of reagent in proportion to the extent of pH deviation.

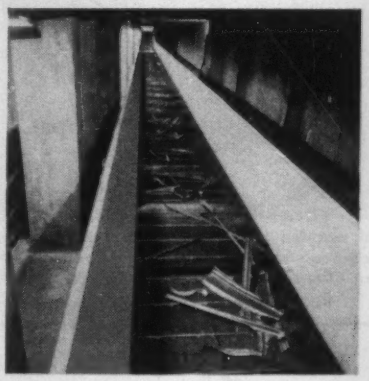
Proportioning or throttling control can be obtained by electrical means with a motor driven valve or by pneumatic means with an air operated valve. A pneumatic proportional controller is available as a single instrument that consists of a recording-controlling potentiometer with booster and bleed valves to produce an output air pressure that will govern the position of an air operated diaphragm valve. The control system then consists of an electrode assembly, a pneumatic controller and a pneumatic valve.

There is no preferred system for pH control. The system selected will depend primarily on the frequency of addition of reagents. This frequency of addition in turn will depend on the rate of shift of pH and the range that must be held to assure a quality product. The necessity for pH control is determined by starting with the chemistry of the process. Where occasional addition of reagents is required, as for electroplating baths, then manual readings and additions may be satisfactory. Where automatic control is required basic instruments can be assembled for any combination of single or multiple point reading, recording or controlling.

The author is indebted to Leeds & Northrup Co. and to Beckman Instruments Inc. for technical assistance in the preparation of this article.



At the delivery end, this system changes from underfloor to overhead and delivers the scrap directly to automatic balers. After being baled in 2' cubes, the scrap is automatically transferred by a Planet pusher bar conveyor to railroad cars.



This Planet apron conveyor, moving through a tunnel under trim presses, automatically delivers to the balers up to 20 tons of loose scrap per hour. A simple clutch-operated auxiliary drive assures continuity of operation.

PLANET
ENGINEERED SYSTEM
automatically handles 20 tons of scrap per hour

For a leading automobile plant, Planet recently engineered and installed a 1200 foot system to handle the scrap from trim presses having a combined capacity of over 4000 tons. Because the entire operation is automatic, this scrap handling system saves time and money . . . and baled scrap is worth more, too.

It paid this manufacturer to use Planet's engineering know-how. If you have a scrap handling problem it will pay you to write or phone today and "PLAN WITH PLANET"

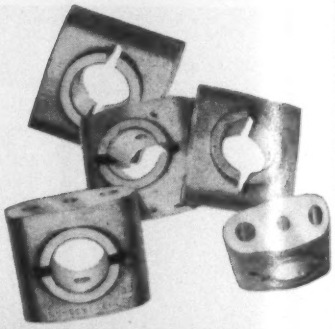
PLANET CORPORATION

1810 SUNSET AVE., LANSING, MICH.

- ENGINEERED HANDLING SYSTEMS
- AUTOMATED EQUIPMENT
- FOUNDRY HANDLING SYSTEMS

65

AUTOMATED BROACHING
BALANCED PRODUCTION
with two machines



ANOTHER

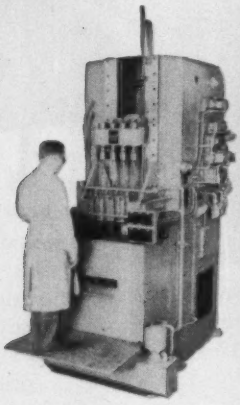
American

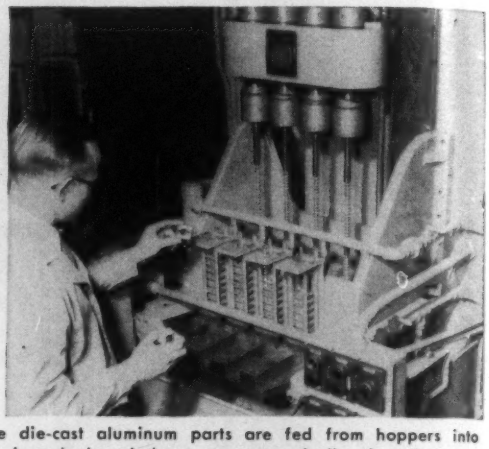
FIRST

This "working team" of two American Broaching Machines produces 3,000 rocker arm brackets per hour.

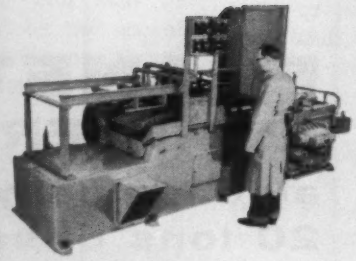
An American (VP) vertical hydraulic internal pull-up broaching machine, arranged for 4-station operation, broaches the ¾" diam. hole in the part. The part is then conveyed to a hydraulic broaching machine, which straddle broaches the sides of the parts. The feeds, broaching strokes and ejectors of the two machines are completely automated to provide continuous, balanced production.

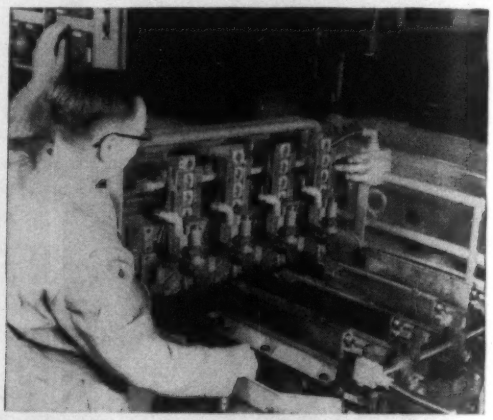
American machines, broaches and fixtures are made in sizes and types to fit your exact requirements. Why not let American engineers solve your broaching problems. Send a part print or sample. Ask for Catalog No. 450.



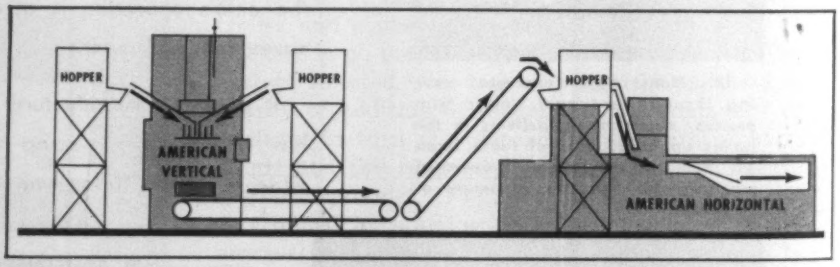


At the vertical machine, the die-cast aluminum parts are fed from hoppers into magazine feeds, the hole is broached and the parts automatically ejected onto a conveyor. Cycle is continuous.





Expanding arbors of the horizontal machine pick up the parts from magazine feeds and push them past stationary broaches which straddle broach the sides. Parts are ejected automatically on the return stroke.



AMERICAN *American* BROACH & MACHINE CO.

A DIVISION OF SUNDSTRAND MACHINE TOOL CO.

ANN ARBOR, MICHIGAN

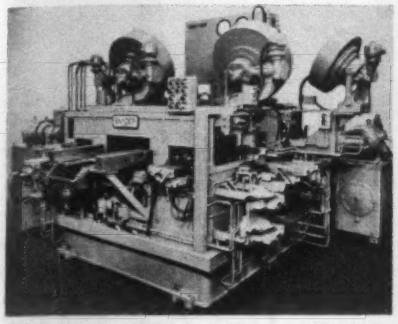
SUNDSTRAND

See *American* First — for the Best in Broaching Tools, Broaching Machines, Special Machinery

AUTOMATION new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17



Cylinder Head Assembly

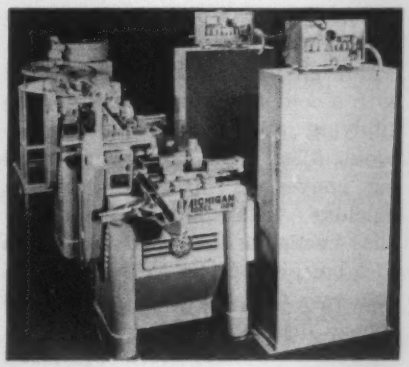
Automatic machine applies sealer material and assembles three welch plugs in automotive engine cylinder heads, air tests the finished assemblies and automatically rejects from the machine any heads that do not meet the test standards. New seven-station, in-line transfer machine is loaded from a conveyor. In automatic sequence, the machine applies sealing compound to three holes in the head, presses in three welch plugs, air tests the assembly for leaks, rejects faulty heads from the line and unloads the head and plug assembly on a conveyor line.

Unusual feature of the machine, which assembles 130 heads per hour at 80 per cent efficiency, is that it makes right and left hand cylinder heads by alternately pressing plugs into opposite ends of the heads as they pass through the machine. Welch plugs are fed to the machine from individual hopper feeds that deposit one plug at a time in front of hydraulically powered plungers that press them into the heads. Maximum stroke switches on each plunger govern the machine cycle in such a manner that parts will not be transferred if any plug is not pressed to depth. The cylinder head and welch plug automatic assembly and testing machine has a welded steel base and two individual hydraulic power units. A centralized lubrication system is provided for the machine. **Snyder Tool & Engineering Co.**, 3400 E. Lafayette, Detroit 7, Mich.

Circle 401 on Inquiry Card

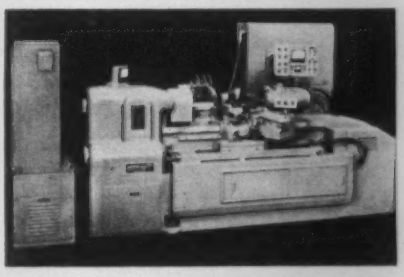
Audio Testing Gears

Fully automatic sound testing of transmission gears in automotive and similar mass production applications is possible with automatic Model 1126 gear speeders. The entire operation including feeding of parts from a storage hopper, clamping and speeding of the gear and either selective rejection for excess noise in any frequency band or passing the gear being tested, is done automatically.



Mass produced or helical gears either single or in a cluster can be automatically audio tested to exact specifications. The electronic panels can be set up to reject gears for undesirable noise levels of high, low or intermediate frequency at particular speeds within the working range of the gear. In addition the time required to speed test marginal gears is reduced. Model 1126 speeders can be set up in line to check automotive pinions, as illustrated. **Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit 12, Mich.

Circle 402 on Inquiry Card



Automatic Lathe

Designed to fulfill the needs within the area between plain engine lathes and automatic production lines, Model 21 MonaMatic lathe produces a large volume of close tolerance workpieces. Like an engine lathe, the machine has a headstock to drive the workpiece, a bed to support the carriage and a tailstock to support the rear end of the workpiece.

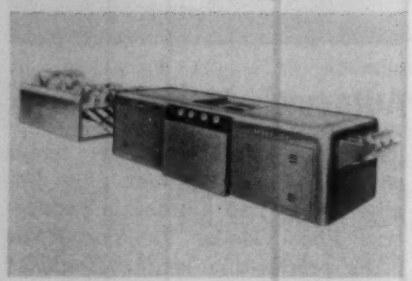
The carriage is supplied with an angular tracer controlled slide which operates on an air-gage tracer principle. The tracer operates from either of two rough cut control stops or rough and finish templates as dictated by the control system. A large hydraulic tank at the tailstock end of the bed supplies hydraulic power to operate the air-gage tracer, and the air hydraulic servo relay valve is mounted adjacent to the power cylinder to keep the variable pressure lines as short as possible.

The headstock is normally equipped with an air operated chuck, and air operating lines from the handle at the top of the tailstock control both the air operated chuck and the air operated tail-

stock. As the control handle is moved forward, the tailstock spindle advances. A detent prevents further motion of the handle until the workpiece is firmly held between centers. Then the handle can be moved further to close the chuck jaws. Further advancement of the handle clamps the tailstock spindle.

The lathe cycle is controlled from the programmer which is a stack of cams arranged to control the successive operations. As many as 24 control cams are mounted on a control shaft which is permitted to index 1/20 of a revolution upon signal. The control cams each control a microswitch which in turn actuates different functions of the machine. Completely new and different machine cycles are available by placing a new stack of cams in the programmer. **Monarch Machine Tool Co.**, Sidney, O.

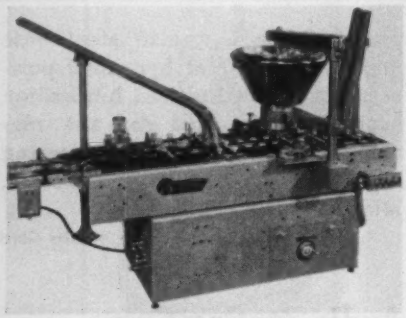
Circle 403 on Inquiry Card



Continuous Packaging

Complete packaging of products in either a bubble or contour package is provided by automatic machine. Continuous packaging is accomplished through lamination of two sheets of clear plastic at a speed of 5 to 20 fpm. Machine automatically inserts the product being packaged, heat seals, prints, and trims individual packages or rewinds the packaged production in a continuous ribbon. Called the Mercury, the machine is designed for Rol-Pak, a patented process of packaging, and for other continuous vacuum forming on small parts, bubbles or containers. Features of Rol-Pak are: High speed packaging, visibility of product through clear plastic; savings in storage space by keeping the individually packaged items in a large roll; no soiling of product or package—moisture proof; and elimination of loose stock. Individual packages in the roll are perforated for easy removal from the display or service roll. Maximum roll width of the conveyor is 14 inches or multiples of ribbon strips. More than one ribbon can be fabricated simultaneously. **Comet Industries,** 9865 Franklin Ave., Franklin Park, Ill.

Circle 404 on Inquiry Card



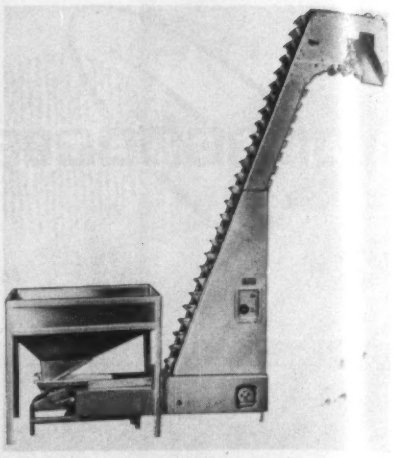
Processing Cookies

Cookie sandwiching machine capable of making up to 1400 sandwiches per minute is a two-machine combination that will make and package sandwich cookies. The fully automatic machine feeds base cakes to twin conveyors, applies filling to the bottom cakes, positions top cakes to complete the sandwich and delivers finished sandwiches neatly stacked in two rows, or counts and groups sandwiches for automatic packaging. Sandwich maker can be combined with a company bag sealing header applying machine which receives cookie-filled bags from a packaging conveyor, times bags into a machine, tucks bag gussets, applies header or label and heat seals the bag and label. **Peters Machinery Co.,** 4700 Ravenswood Ave., Chicago 40, Ill.

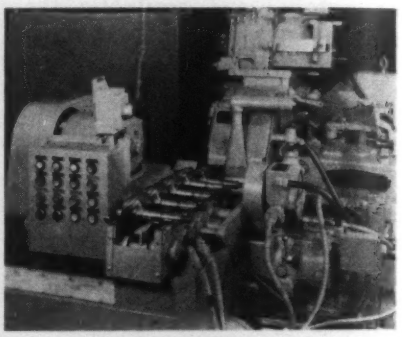
Circle 405 on Inquiry Card

Bucket Elevator

Developed for elevating and conveying bulk materials, Robo-Lift bucket elevating conveyor provides food processors and packers with gentleness of operation, sanitation, compactness and flexibility. It operates vertically, horizontally, or performs combined movement without transfer. Infeed of the Robo-Lift is accomplished by any of a number of standard methods—vibratory, belt, etc. Material is fed gently into buckets, not scooped, avoiding waste and damage. Versatility of the conveyor lends itself to a variety of food, confection, drug and chemical handling applications. **Lynch Corp.,** 2304 Capital, Anderson, Ind.



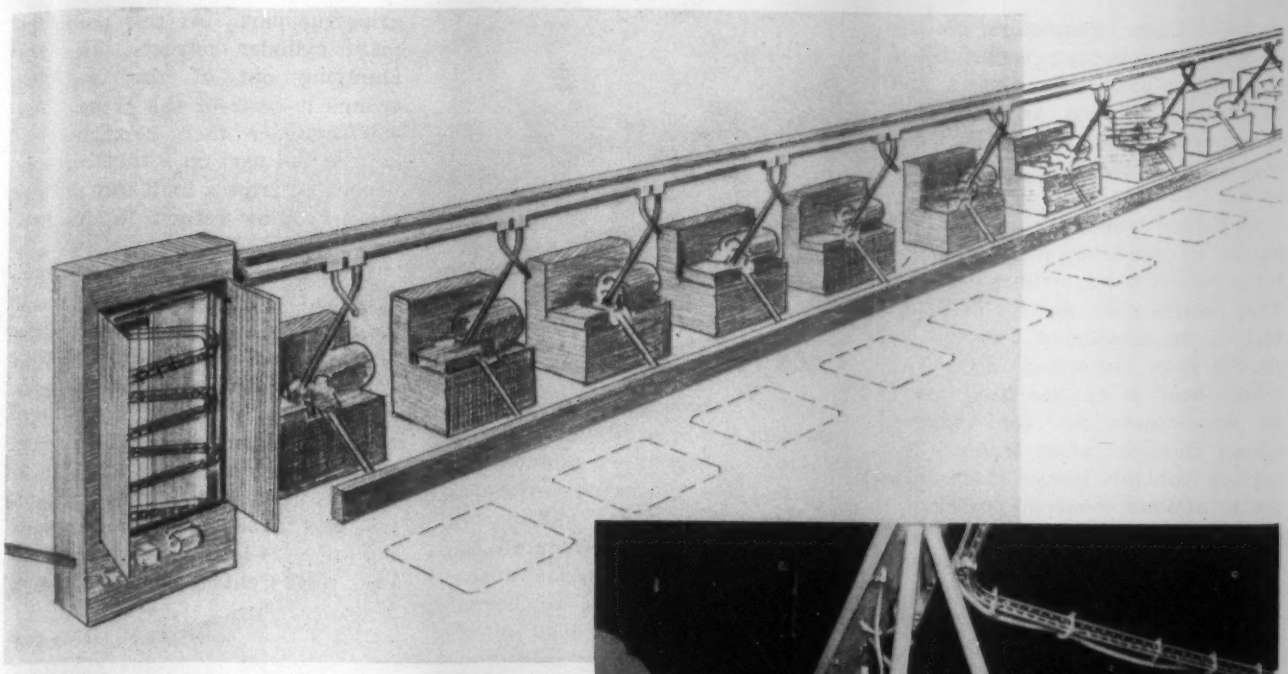
Circle 406 on Inquiry Card



Pinion Grinder

New machine for grinding stem pinions features special workholding and driving equipment with automatic loading and unloading devices. Automatic controls are incorporated into this machine to permit one operator to supervise the production of more than one machine.

Pinions are placed in a loading chute which automatically moves the pinion down inclined ways toward a revolving turret which then places it in position for the footstock center to engage the center hole and push it forward into the floating type collet on the headstock. The grinding cycle time is preselected on the basis of stock removal and finish require-



A Z-LINE . . . Automatic manufacturing, utilizing conventional machine tools.

It is in use, now, for gear blanks, bearing races, pistons, tappets, and many screw machine parts.

A Z-LINE automatically, and without synchronization, meets the demands of *individual machines.* Thus, you get low cost production, maximum machine utilization, production flexibility, superior handling.

EST. IN 1949

CARGILL DETROIT CORPORATION

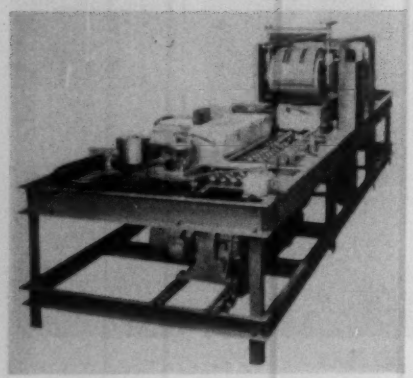
Designers and Builders of Automatic Manufacturing

2254 Cole Avenue • Birmingham, Michigan

ment. Upon completion of the grind, the revolving turret takes the pinion from the centers and discharges it into an unloading chute from which it rolls onto the conveyor on the front of the machine.

Grinding wheel truing is automatic at predetermined intervals by a wheel head mounted device. This device also gives close control of the amount of abrasive removed from the wheel face. The wheel head is automatically reset to compensate for the reduced wheel diameter after truing. Interlock controls assure that automatic actions occur in proper order; improper action shuts down the machine. **Norton Co.**, Worcester 6, Mass.

Circle 407 on Inquiry Card

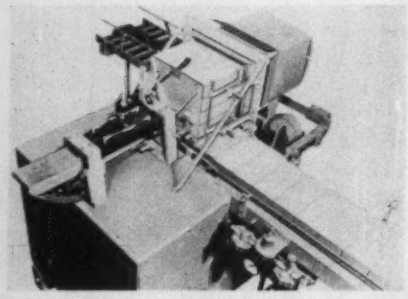


Automatic Imprinter

Used to stencil wooden shipping boxes for 75, 90 and 105 mm artillery ammunition, automatic imprinting machine prints clean, sharp impressions on five sides, eliminating all hand stenciling and marking. Boxes are fed and discharged automatically, without requiring attention.

A metering ink roller in the printing head automatically controls the amount of ink delivered to the dies, which may be of the permanent rubber or interchangeable type. A variable speed drive matches production rates of from 600 to 1200 units per hour. Machine may be split into single units with multiple variations and adapted to any specifications required. **Industrial Marking Equipment Co. Inc.**, 454 Baltic St., Brooklyn 17, N.Y.

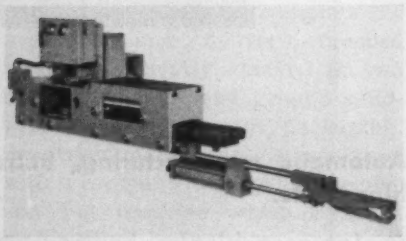
Circle 408 on Inquiry Card



Package Caser

Called the Sure-Way Caser, packaging device fills cases at up to 240 packages per minute and is adaptable to a wide variety of package sizes, types and casing patterns. The unit features automatic, fast and precise operation which is flexible to permit changes of loading patterns. It is gentle in handling overwraps and labels, as well as out-of-size frozen food packages. Sure-Way is used for such products as rice, prunes, cake mixes, frozen fruit and vegetables, dried fruit, soap, etc. **Stokes & Smith Co.**, 4900 Summerdale Ave., Philadelphia 24, Pa.

Circle 409 on Inquiry Card

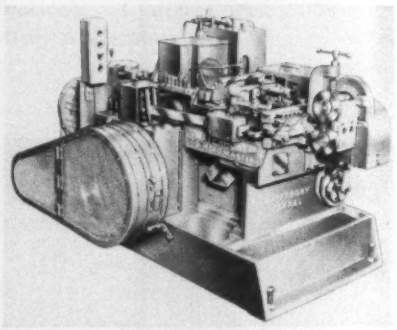


Press Unloader

Developed to utilize the full capacity of presses, to provide savings in the unloading operations, to improve safety conditions by reducing unloading accidents and to reduce production costs, press unloaders are fully self-contained, automatic machines. In operation the unloader is synchronized with the press through a limit switch, and is operated by two air cylinders—a main cylinder or lift cylinder, and a jaw cylinder for opening and closing the jaws. When the press signals that it is clear for unloading, the jaw cylinder moves the open jaw forward. At the end of the forward stroke, the jaw grips the part. At this point the main cylinder retracts, lifts the stamping out of the die, and swings it clear of the press. The jaw cylinder then retracts, unclamps the part on a table or conveyor and trips a limit switch. The main cylinder returns to its normal waiting position.

Unloaders are available in five standard sizes to meet most unloading conditions. Jaw widths are adjustable for different width parts, for different loading heights and for the angle of travel into the die. Illustrated unloader has a main cylinder stroke of 12 inches; through a double rack and pinion, this stroke is doubled, resulting in a 24-inch traverse. **Sesco Inc.**, 8881 Central Ave., Detroit 4, Mich.

Circle 410 on Inquiry Card

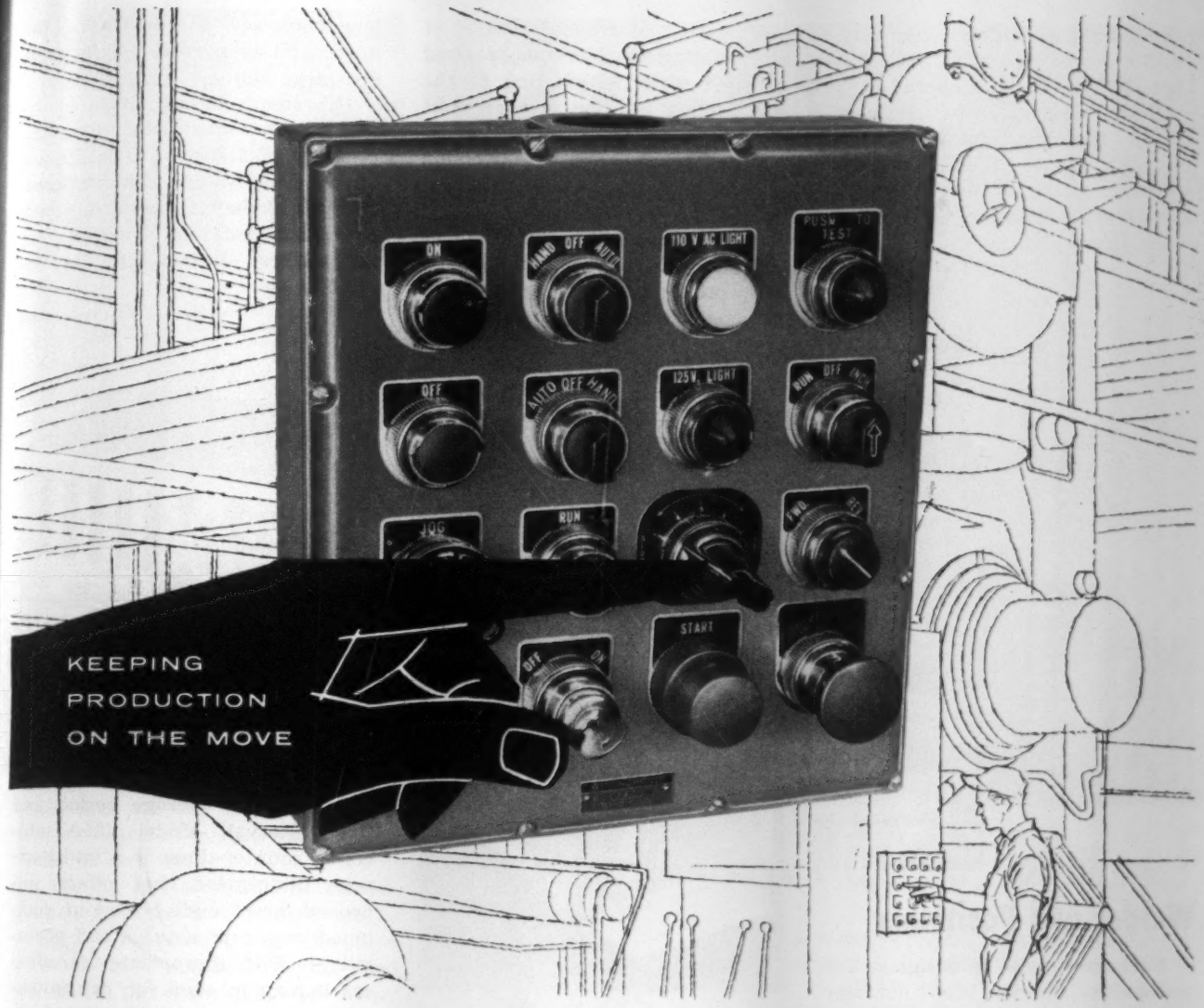


Double Stroke Header

Solid die, double stroke, cold heading machine has production rates ranging from 300 to 450 screw or rivet blanks per minute. Called the Headmaster, the machine will head rviets up to ⅛ by ¾, machine screws up to #6 by ¾ and sheet metal screws up to #8 by ¾.

Features of the new machine include horizontal shifting punches, toggle actuated gate mounted on rods, friction roll feed, individually adjustable punch holders, cam operated shifter and cutoff, magnetic brake, sturdy cutoff and transfer lever, all shafts mounted in roller bearings, centralized lubrication system and variable speed drive.

Toggle actuated gate mechanism provides two blows, one long stroke and one short stroke, for each flywheel revolution. The gate advances rapidly and then decelerates on contact with the blank,



. . . with Westinghouse Oil-Tite control stations—1 to 16 units

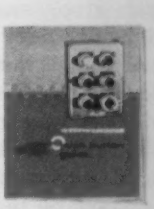
Interchangeable parts — stations, contact blocks, operators and indicating lights — right off the shelf, quickly give you a "tailor-made" Westinghouse Oil-Tite* control station to meet the requirements of any heavy-duty industrial equipment application.

Enclosures — die-cast and Bonderized — include cork-neoprene gasketing and close machine fits as positive seals against exposure to oil, coolants, cutting compounds, water and other foreign matter.

*Trade-Mark

New Pushbutton Guide

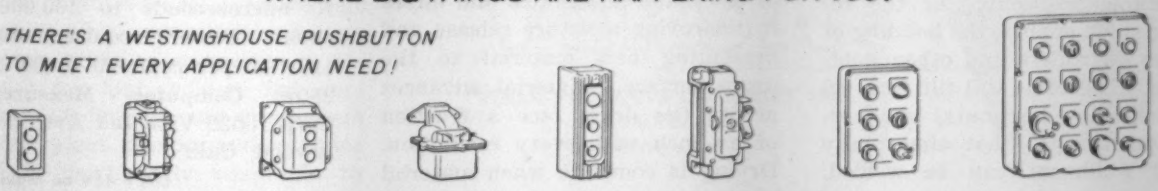
For more facts on why it will pay you to standardize with Westinghouse control stations, get a free copy of the new *Pushbutton Guide*, booklet B-6749. See your nearby Westinghouse salesman or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30210



WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU**!*

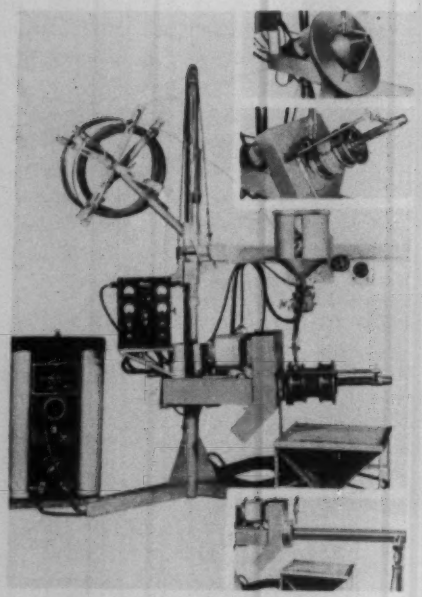
THERE'S A WESTINGHOUSE PUSHBUTTON TO MEET EVERY APPLICATION NEED!



Circle 578 on Inquiry Card

producing a squeezing action rather than an abrupt blow. The fact that the gate is rod mounted helps maintain accurate tool alignment while the horizontal shifting punches reduce the number of working parts. **Waterbury Farrel Foundry & Machine Co.**, Waterbury, Conn.

Circle 411 on Inquiry Card



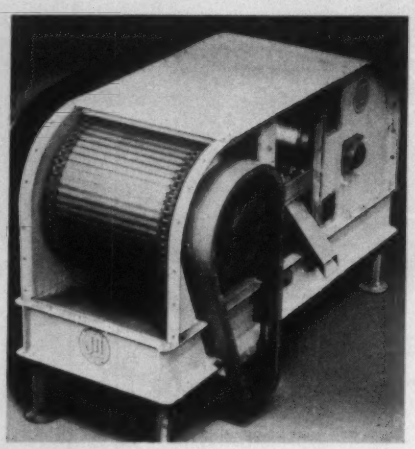
Welder and Positioner

Packaged unit is designed for automatic welding on circular shapes such as rolls, idlers, sheaves, crusher rolls and for longitudinal weldments. Called the Rexarc RP-43, the unit controls welding operations and rotates workpieces simultaneously with stopping and starting of arc. Voltmeter and ammeter indicate welding currents properly. Positive neutral stop, snap-action, motor rated heavy duty switches on the control panel insure trouble free service in the field and minimize the danger of errors in operating double throw switches. High frequency generator assures automatic start of the arc and stabilizes the arc during welding operations.

The 120-degree tilting table for adjustable positioning of the rotating shaft enables the building of flanges on rollers and other weldments. The table will tilt from 30 degrees below horizontal to a vertical position, so that almost any round weldment can be welded. Automatic and manual control of the rotating shaft is synchronized to start with the starting of the arc. Shaft rotation is reversible. The rotation stops with the sticking of the rod, or the extinction of the arc, as protection against possible equipment damage.

The 100-lb visible flux hopper has a heavy transparent plastic strip on the side and a clear plastic conductor tube, enabling the operator to determine the flux supply accurately. Two adjustable wire reels for welding wire coils 12 to 26 inches in diameter handle any size welding wire coil available. **Sight Feed Generator Co.**, W. Alexandria, O.

Circle 412 on Inquiry Card



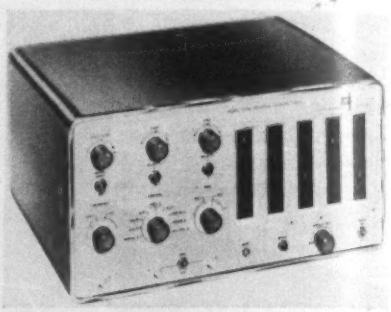
Drum Type Dryer

Used for batch or continuous drying of feeds ranging from pasty or doughy mixes to distinctly granular material, drum type dryer is called the Drumulator. A stainless steel heated drum with flanged outer edges carries a continuous stainless steel belt. Material is dried in the space between the heated surfaces of the drum and belt. Material is forced across the drum face by continuous introduction of new feed material. It is in contact with the drum for 2/3 revolution, and then plowed off and again fed to the drum.

Repeated plowing off and return of the material agitates and mixes it, improving moisture release and presenting new material to the drum surface. Material advances across the drum face a fraction of an inch with every revolution. Drying is complete when material has traversed the width of the drum and is plowed off into the discharge chute.

The steam heated drum is designed for maximum operating pressure of 150 psi. Gas, oil, hot air or hot water can be used. Drumulator handles material which previously could be dried only on tray dryers. **Jeffrey Mfg. Co.**, Columbus, O.

Circle 413 on Inquiry Card

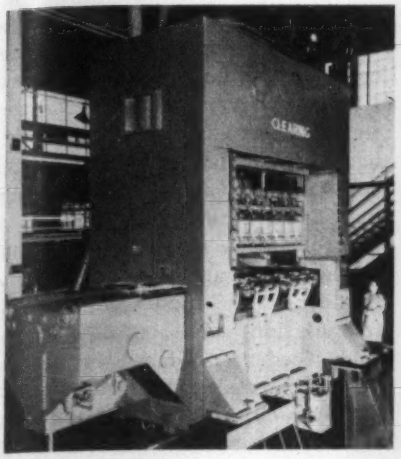


Counter-Timer

Designed for the precise measurement of frequency, frequency ratios, period, average period and time interval, Model 225A universal counter-timer is a multipurpose instrument that offers improved direct digital readout combined with compactness and portability. With appropriate transducers it may be used for determination of pressure, velocity, acceleration, displacement, flow, rps and rpm. The instrument also serves as a secondary frequency standard.

Features of the counter-timer include: Three direct coupled inputs, quick time base alignment, 70 mv sensitivity, provision for oscilloscope marker signals for trigger level adjustment on complex wave forms. Three independent threshold controls permit adjustment of trigger levels at any voltage from −50 to +50v with the resolution of 70 mv. Frequency range is from 0 to 100,000 cps; period measurement range is from 10 microseconds to 100,000 seconds; time interval range is from 10 microseconds to 100,000 seconds. Power requirements are 117v 10 per cent, 50 to 60 cycles, 280w. **Computer - Measurements Corp.**, 5528 Vineland Ave., N. Hollywood, Calif.

Circle 414 on Inquiry Card



Automatic Presses

Known as the Transflex, multiple purpose automatic presses are designed to be used for producing a number of different parts and to be changed from one job to another quickly and easily. The automatic feed which carries the piece-part through the press has been designed so that the feed stroke—or distance the part is moved—is adjustable. A Transflex feed may be indexed any distance required by the number and size of dies used.

Simple adjustments are provided so that the feed fingers can be quickly respaced along the feed bar to accommodate varying feed lengths. Fingers may be easily changed to grip parts of different dimensions. Die cushions are mounted on a track within the press bed. Presses are furnished with adjustable knockout positions. Air cylinders eject the part when the slide is raised. Positive mechanical knockout is also provided in the event a part becomes so firmly seated in the dies that the cylinder remains compressed. Both cylinders and rods are adjustable left and right. **Clearing Machine Corp.**, 6499 W. 65th St., Chicago 38, Ill.

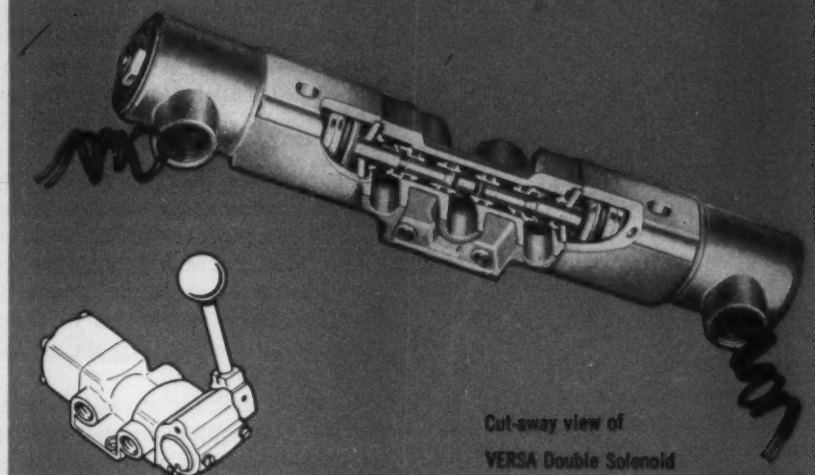
Circle 415 on Inquiry Card

Belt Grinder

New contact wheel abrasive belt machine which permits four simultaneous grinding operations is designed for high volume flat surfacing of ferrous and nonferrous metals, glass, plastics and ceramics and is particularly adaptable to

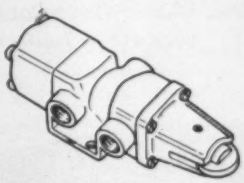
VERSA Control Valves

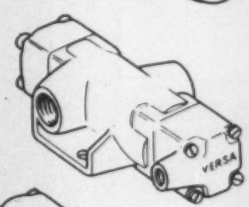
FOR IMMEDIATE DELIVERY...

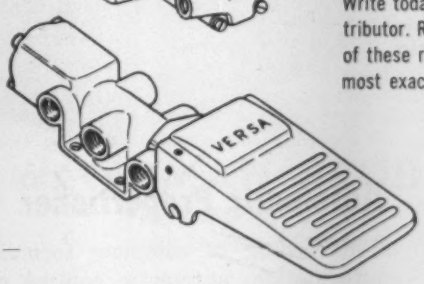


Cut-away view of VERSA Double Solenoid Valve, 4-way type.

in Over 110,000 Variations!







Versa Valves are available in 2-, 3-, 4-, and 5-way types with over 20 actuating devices, in sizes from ⅛" to 1" N.P.T., and for pressures from partial vacuum to 500 PSIG.

The entire line of Versa Valves (over 110,000 variations) are stocked by authorized Versa distributors, strategically located throughout the United States and Canada.

All Versa Valves are triple pressure and functionally tested under water for guaranteed leakproofness . . . actually exceed J.I.C. standards.

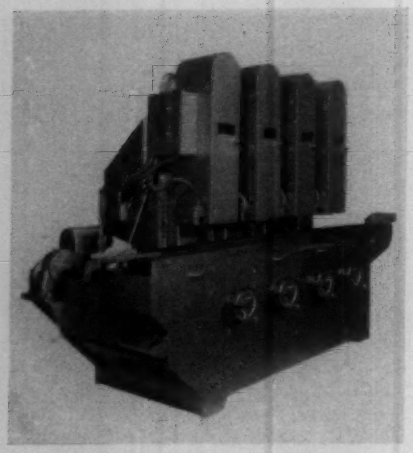
Write today for the name of your nearest Versa distributor. Remember, you can get immediate delivery of these rugged, compact control valves to fit your most exacting hydraulic or pneumatic requirement.

The entire line of VERSA Valves is explained in our new comprehensive Folder #14

VERSA

VERSA PRODUCTS COMPANY INC.
248 SCHOLES STREET
BROOKLYN 6, N. Y.

Circle 580 on Inquiry Card



automatic production levels. The four-head Model 680-4 belt grinder produces fine microinch finishes to exacting tolerances, and makes possible a single-cycle operation from rough casting to polished part. Typical multiple grinding sequence, using a series of progressively finer belts is: Rough grind, two semifinishes, and finish grind. One pass under the four heads can remove an approximate maximum of 0.020-inch of steel stock and up to 0.060-inch for other materials and applications. The grinder is applicable to both wet and dry belt grinding. Approximate capacity of cooling unit, equipped with ½ hp coolant pump is 100 gallons. Parts can be conveyorized for presentation to the conveyor belt, automatically ejected and carried to the next operation. Size of machine conveyor belt is 6½ inches by 216 ft. Abrasive belt size is 6 inches by 80 inches and abrasive belt speed of individual heads is constant at 5500 sq ft per minute. **Engelberg Huller Co.**, 831 W. Fayette St., Syracuse 4, N. Y.

Circle 416 on Inquiry Card

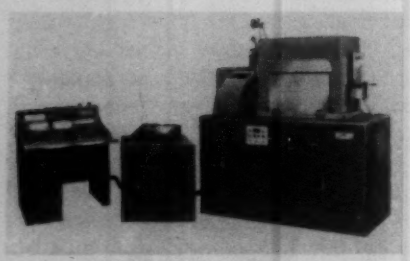


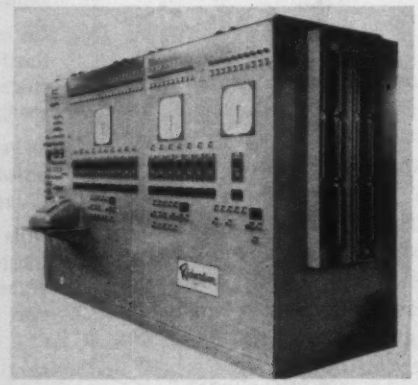
Plate Embossing

High speed electronic data processing machine automatically sets type and embosses metal plates for identification, writing or addressing, while simultaneously performing four auxiliary operations to prepare plates for many industrial systems applications and control procedures. Known as Databosser V100-EW, the common language machine adaptable to integrated data processing, is activated and cycled in its operations by punched cards, punched tapes or magnetic tapes.

In addition to its typesetting and embossing functions, the Databosser can automatically and simultaneously attach tying wires to plates, emboss sequence numbers, coat embossed characters for easier reading and notch plates for coding or sorting.

When cycled for repetitive production the equipment delivers up to 6000 completed plates per hour. When activated by punched cards or tapes the Databosser will automatically set type for an emboss at an average of approximately 1000 different plates per hour. Each plate can contain three lines of variable data and two additional lines of repetitive data, with 20 characters on each line. **Dashew Business Machines Inc.**, 5886 Smiley Drive, Culver City, Calif.

Circle 417 on Inquiry Card

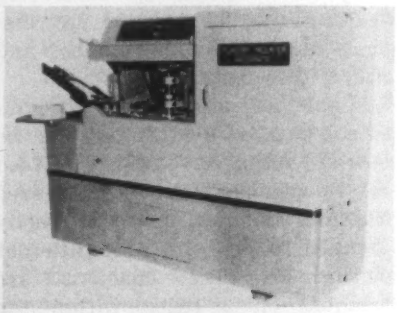


Automatic Proportioner

Recording of complete formula information, automatic control of a total of 43 feeders and electronic interlocking of all aspects of a complex proportioning system are some of the features of the electronic Select-O-Weigh system. Designed for proportioning grain and feed formulas in a large feed mill, the system includes a printing mechanism interlocked with the automatic panel. The printer records complete formula information for each batch that is proportioned. Information is electronically transmitted through the control panel from actual weighings from feeders.

Information is recorded by numerical code and includes formula number; time, month and day of formulation; final cutoff point of each feeder; feeder identification number; total cumulative weighing of each scale; and grand total of all three scales. Select-O-Weigh panel controls a three-scale weighing system, with pushbutton control and remote indicators for each scale on the face of the panel. The first scale system can automatically proportion any ten ingredients from 23 feeders; the second, any seven of ten; and the third, any one of ten. **Richardson Scale Co.**, Van Houten Ave., Clifton, N.J.

Circle 418 on Inquiry Card



Automatic Film Mounter

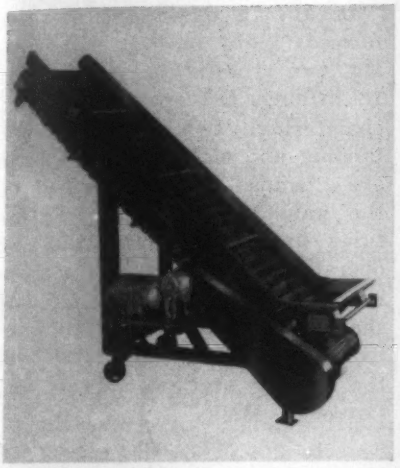
High speed, automatic unit for mounting microfilm frames to all standard types of cards is known as the FMA Automatic Mounter. The unit handles 35mm film, mounting in aperture cards at the rate of 3000 frames an hour, and will accommodate 100-ft or 1000-ft rolls of film, either negative or positive.

Feature of the unit is an automatic detection system which immediately stops the mounter when any one of the operational stations fails due to card imperfection, film not meeting specifications, error in either film or card sequence, equipment failure or operator error. The machine shuts off at a point where the card can easily be removed, checked and a new card inserted

or the error corrected, thus eliminating the necessity for prechecking of film to determine whether or not it meets specifications.

Operation of the mounter is as follows: Protective glassine is stripped from the card aperture; film is advanced, with an electronic scanner controlling pulldown to within 0.010-inch accuracy, cut and sealed to card frame; and accurate count is made of film frames and cards. **Filmsort Div., Dexter Folder Co.,** 50 S. Pearl St., Pearl River, N.Y.

Circle 419 on Inquiry Card



Conveying Hot Forgings

Designed especially for heavy loads, new conveyor handles hot forgings. Conveyor is equipped with a heavy duty wire mesh belt. Heavy objects with slick surfaces or heavy objects of awkward shape present no handling problem. Conveyor is designed to cut material handling costs in plants, foundries, forging plants or warehouses by eliminating chutes and saving valuable floor and aisle space. Material can be taken directly from presses, benches or loading docks and transferred to other operations, stock boxes or conveyor lines in a minimum distance. To provide ease of handling, heavy duty unit is provided with casters and handles placed on each side. Wire mesh belt is available in a variety of weaves and with any spacing and size of flight; motors are available in standard voltages to meet user's needs. **Cooney Industries Inc.,** 17245 E. 10 Mile Rd., E. Detroit, Mich.

Circle 420 on Inquiry Card

PANELSCOPE

by Waterman

FOR AUTOMATIC PORTRAYAL

SIZE:
5-1/4" x 5-3/16" x 10"
5 Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The Waterman PANELSCOPE is a custom-built cathode ray tube oscilloscope, with simplified operation, and yet available at a low price. The PANELSCOPE concept provides for the following:

- MINIATURIZATION — Panel space required is only 5¼" x 5-3/16" — depth is 10" and the weight is less than 5 lbs. The PANELSCOPE can be installed in practically any equipment — mobile or stationary air, sea, or land — military or commercial.
- SIMPLICITY OF OPERATION — Twist of a single rotary switch provides a synchronized pattern of desired incoming signal (up to 11 circuits) against proper linear time base. This is ideal for monitoring and trouble shooting, as it removes the need of fiddling with knobs as it is done now on general purpose oscilloscopes. The static controls, such as beam, focus, positioning, and graticule brightness are located in tube escutcheon.
- CUSTOM DESIGN — A wide variety of — signal amplifiers with response from dc to megacycles and sensitivities from 5 millivolts — synchronized or triggered linear time base generators from ½-cycle (and lower if need be) to 2 microseconds — can be specified by you to fit your needs for particular equipment.
- PARTIAL KIT FORM — The PANELSCOPE comes fully wired and tested with chosen signal amplifier, linear time base generator and attendant sync. amplifier. The desired signal attenuators, frequency and amplitude determining components, and method of synchronization can be installed either by us or by you.
- POWER REQUIREMENT — Less than 10 watts of line power for built-in high voltage supply — The required B+ and heater current as selected by your requirements. For those cases where B+ and heater power is not available, auxiliary power pack can be supplied.

There is a place in your equipment for Waterman PANELSCOPE, a custom built oscilloscope at production prices, although your needs may be but one or two. May we have your requirements?

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

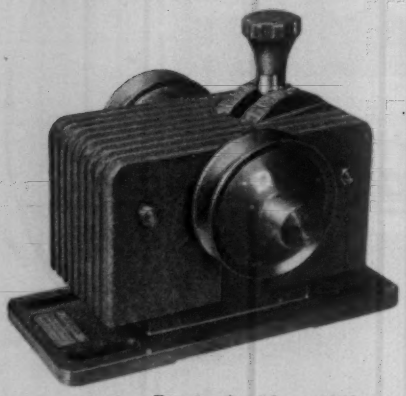
MANUFACTURERS OF

PANELSCOPE*
S-4-C SAR PULSESCOPE*
S-5-C LAB PULSESCOPE*
S-11-A INDUSTRIAL POCKETSCOPE*
S-12-B JANized RAKSCOPE*
S-12-C SYSTEMS RAKSCOPE*
S-14-A HIGH GAIN POCKETSCOPE*
S-14-B WIDE BAND POCKETSCOPE*
S-14-C COMPUTER POCKETSCOPE*
S-15-A TWIN TUBE POCKETSCOPE*
RAYONIC* Cathode Ray Tubes and Other Associated Equipment

*T. M. REG.

Circle 581 on Inquiry Card

Regardless of Cost..... You Can't Get A Better Variable Speed Transmission

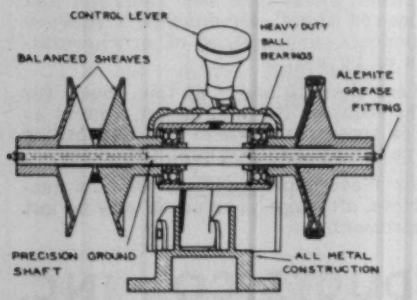


Fractional to 5 hp. at 1750 rpm. Ratios to 10 to 1. Lever (shown) or handwheel control.

Lovejoy

SELECT-O-SPEED

- Inexpensive compared to other infinitely variable speed transmissions.
- As easy to install as an ordinary V-Belt drive.
- Uses standard V-Belts.
- Infinitely variable over wide speed ratio up to 10:1.
- Changes speed quickly while machine is running.
- Compact—all metal—balanced sheaves—large ball bearings.
- Minimum wearing parts—no expensive replacements.
- Lubrication needed at only three points.

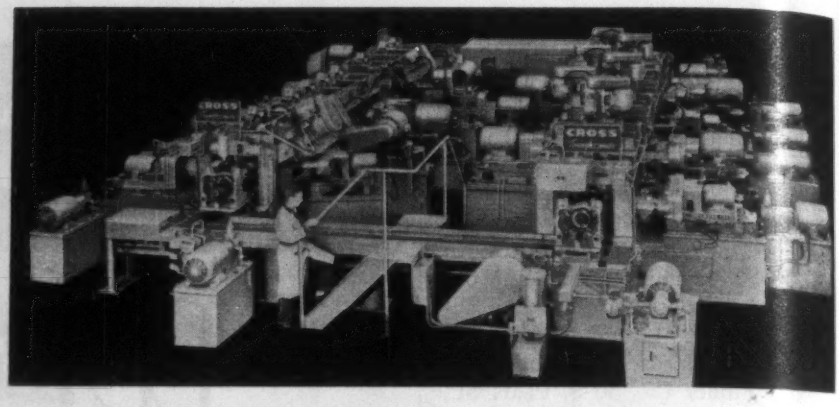


This cut-away sketch shows the practicality and simplicity of the Select-O-Speed's design. Nothing complicated, just two variable pitch sheaves mounted on a pivoted shaft. No internal mechanism—no intricate parts. Shifting the control lever causes a momentary variation in tension between the driving and driven belts which changes the sheave pitch diameters and the driven speed.

Get the facts about the Select-O-Speed. Tell us about your application. We'll give you our recommendations. Request Bulletin 118.

LOVEJOY FLEXIBLE COUPLING CO.
4951 W. Lake St., Chicago 44, Illinois

Circle 582 on Inquiry Card



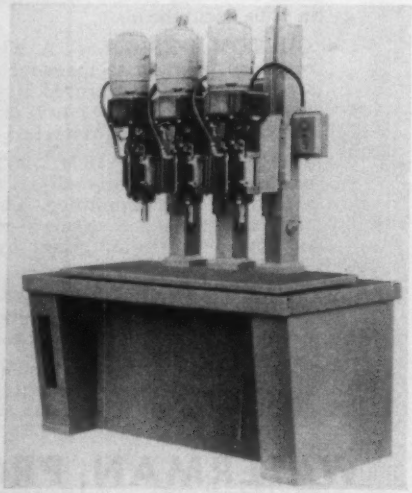
Processing Differential Gear Carriers

Designed to process differential gear carriers and capable of producing 115 pieces per hour at 100 per cent efficiency, multistation machine features automatic lubrication system, hardened and ground ways, hydraulic feeds and rapid traverse.

In operation, the machine rough and semifinish bores the pinion bores and cross bores; rough and finish faces and turns the pilot diameter of the torque tube flange; mills the faces of the cross bore bosses; spotfaces the flange mounting holes; and drills, chamfers, reams and taps all other holes except the flange holes.

In all, 73 operations are performed: eight milling, eight boring, two crossfacing, one turning, 18 drilling, ten spotfacing, seven chamfering, two reaming, nine tapping and eight probing. Parts are clamped and unclamped on the palletized work holding fixtures by means of hydraulically operated torque wrenches. A washing and drying unit for cleaning the fixtures has been installed between the last cutting station and the loading stations. **Cross Co.**, Detroit 7, Mich.

Circle 421 on Inquiry Card



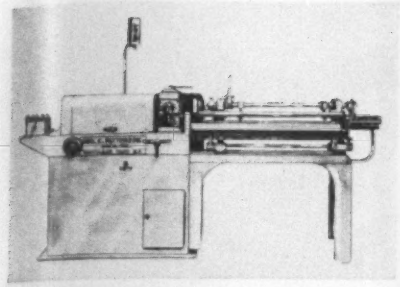
Automatic Drill Press

Designed for automatically performing high production drilling, tapping and other machining operations, automatic drill press incorporates one or more Model 24 Holomatic drill units, a steel weldment base with vertical columns, and complete air and electric power and cycle control systems.

Holomatic unit is an accurate tool feeding device which uses shop air line pressures for thrust and a self-contained, sealed, hydraulic system for spindle travel control. Rapid travel movements, feed rates, and stroke length are all adjustable in both the advance and retract motions. The unit has a 4-inch stroke, a 2-hp capacity and can hold depths to 0.0005-inch. Spindle speeds from 190 to 10,000 rpm can be developed.

Machine base incorporates a wide chip and coolant collection area that drains to a coolant pump reservoir mounting area inside the base. A built-in cycle control system provides for simple manual push-to-start operation or for synchronized operation of the unit with other components such as index tables, shuttle tables, air clamps and other part positioning and clamping devices. **Hause Engineering**, Montpelier, O.

Circle 422 on Inquiry Card



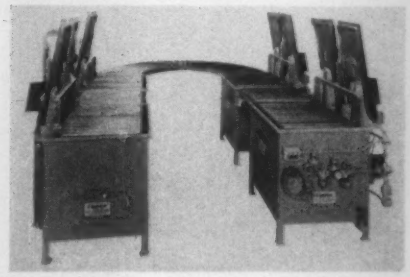
Wire Processor

Automatic wire straightening and cutoff machine straightens and cuts to length wire of various sizes, shapes and materials. Designed to meet the requirements of fabricators of wire, it is capable of fitting into the production lines of the spring industries and other automatic processes. Machine features a positive and sensitive clutch and trip mechanism. These controls make it possible for the machine to successfully handle wire of very small diameters. Machine is electrically operated with variable speed drive so that the high wire speeds can be obtained while the cutoff mechanism completes its action with automatic synchronization. Another feature of the new machine is the wire catcher pan which eliminates many of the problems wire fabricators have met in using machines of this type. The wire catcher pan runs the full length of the machine, up to 8 ft, and is made in two sections joined by a continuous piano type hinge. A locking lever mounted on the extreme end of the machine permits the operator to empty the pan into a tote box without handling the cut lengths. Line of machines is available handling wire of diameters from 1/16 to ¼-inch, from 1/16 to 5/16-inch, and from ⅛ to ½-inch. **Geo. C. Patterson Machine Co.**, 3409 Trumbull St., Cleveland 15, O.

Circle 423 on Inquiry Card

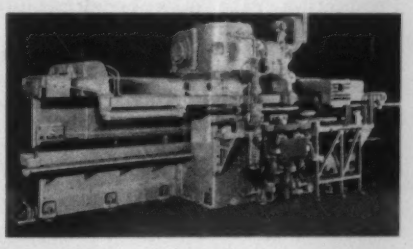
Metal Cleaner & Dipper

Designed for metal cleaning with petroleum solvents, alkalis, emulsion cleaners and other types of commercial metal cleaning and paint stripping solutions, new conveyorized machine provides completely automatic metal cleaning and dipping operation. Machines are also designed for rinsing, rustproofing and various preparatory and coating operations. Small parts are cleaned in baskets, which are conveyed from one tank to another; large parts, such as heavy castings and motor blocks, are individually cleaned and conveyed through the various cleaning and rinsing stages. Parts are loaded flush with top of machine, at normal working height of 36 in., eliminating heavy lifting and the necessity of operator's hands being in harsh chemicals. By pressing a button, loaded rack automatically lowers to the bottom of the machine and the agitation begins.



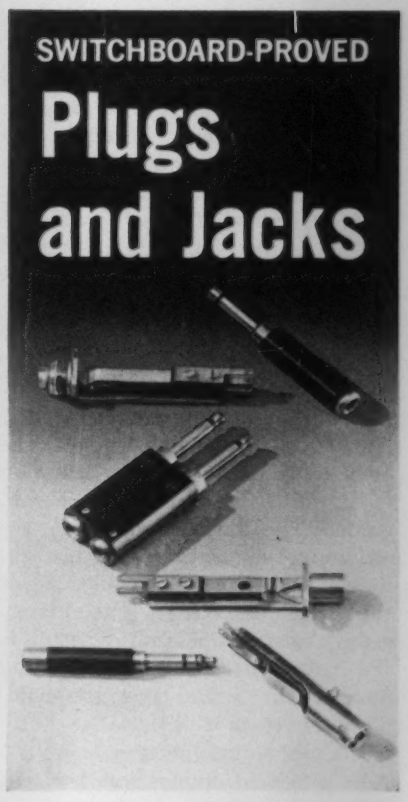
After desired agitation cycle, by pressing a second button, agitation stops and the loaded rack rises flush with the top of the machine for the next operation. Agitation is automatic, not requiring the services of an operator except to load and unload. Where complete automation is required, machines can be furnished with solenoid relays and cam operated timers to automatically load, unload and convey baskets or parts from one operation to the next. When required, the machines can also be equipped for soak cleaning in conjunction with the agitating feature. **D. C. Cooper Co.**, 1467 South Michigan Ave., Chicago, Ill.

Circle 424 on Inquiry Card



Drive Broaching

Model 60-90 ElectroGear horizontal broaching machine features



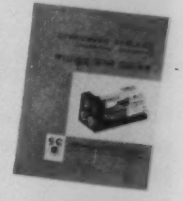
The veteran of telephone equipment suppliers

STROMBERG-CARLSON

offers you the plugs and jacks which survive the torture test of PBX switchboard work!

No matter what programming or patch panel project you have, we doubt if it will subject plugs and jacks to a tougher test than daily use by a telephone switchboard operator.

We've been making these products for this purpose for over half a century. Their ruggedness and dependability are attested by service records in telephone companies from coast to coast—and in installations of our armed forces all over the world.



A CATALOG of Plugs and Jacks has just come off the press and will be mailed to you on request. Or write to the address below for a specific need you may have.

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
TELEPHONE INDUSTRIAL SALES
111 CARLSON ROAD, ROCHESTER 3, N. Y.

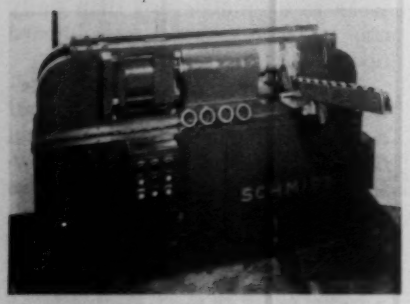
Circle 583 on Inquiry Card

automatic transfering of parts into and out of the workstation and a ram speed continuously variable from 30 to 150 surface ft per minute. Work moves through the broaching station from right to left, in the same direction as the cutting stroke of the broach.

The entire broaching cycle is completely automatic and does not require an operator. Parts to be broached are fed by conveyor into the loading station located at the right side of the machine. From the load station the transfer bar on the ElectroGear machine moves the part onto the hydraulic trunnion fixture at the center of the machine. The fixture swings up, positioning the part for the broaching pass. At the completion of the broaching pass, the fixture swings down and another part is fed into position for broaching and at the same time the completed part moves into the automatic unloading station.

In a typical application, the machine broaches gasket faces on automotive cylinder heads at a rate exceeding 200 parts per hour. Gasket surfaces on these heads are held within 0.002-inch variation despite the high production rate. **Colonial Broach & Machine Co.**, P.O. Box 37, Harper Station, Detroit 13, Mich.

Circle 425 on Inquiry Card



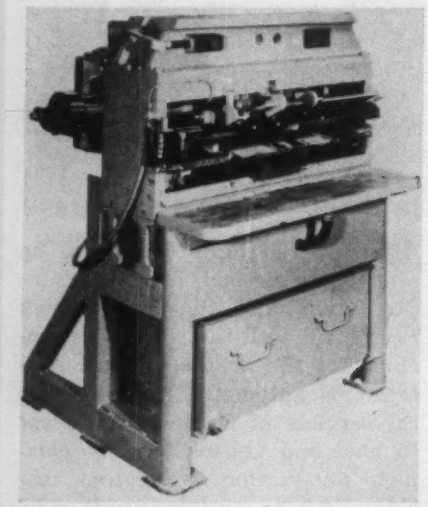
Bearing Marker

Designed for marking the face of bearing races in production, Model 385 machine is operated by a remote hydraulic unit. Its capacity is flexible, being equipped with adjustable feed and discharge chutes, and throat adjustment to accommodate bearings from 15/16 to 3⅞ inches diameter, and thicknesses of ½ to 1⅜ inches. Feed spiders are available to fit each diameter of bearing to be marked.

The remote hydraulic unit consists of a 12 gpm pump, 60 gal tank and a 10 hp motor. It develops 30 tons pressure which will sink lettering dies engraved .025 deep to the background of the characters, providing ample depth for grind on face. The cycle is automatic. A variable drive provides marking capacity from 1250 to 1680 bearings per hour.

Bearings may be fed directly from turret lathe to marking chute; after marking, they roll to the opposite side of the machine into discharge chutes. **Geo. T. Schmidt Inc.**, 4100 Ravenswood Ave., Dept. A, Chicago 13, Ill.

Circle 426 on Inquiry Card



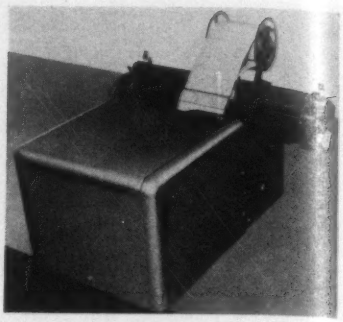
Shaft Knurling Machine

Developed for use in installing the spline type knurl on small electric motor shafts, new model produces a knurl up to 3 inches long on shafts up to 20 inches long, and up to ⅝-inch in diameter. Shafts are hand fed down a magazine, and automatically roll out into a receiving tray after being knurled. Production rate is approximately 3000 shafts per hour. The knurl is installed in a consistently square and uniform manner. A coolant system is built into the machine. **Morley Machinery Corp.**, 1239 University Ave., Rochester 7, N.Y.

Circle 427 on Inquiry Card

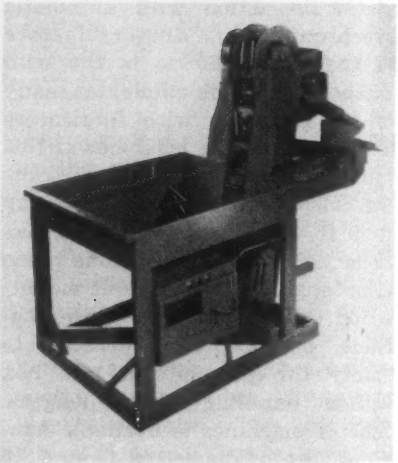
Digital Readout Unit

Serial readout of up to ten digits of identification information and



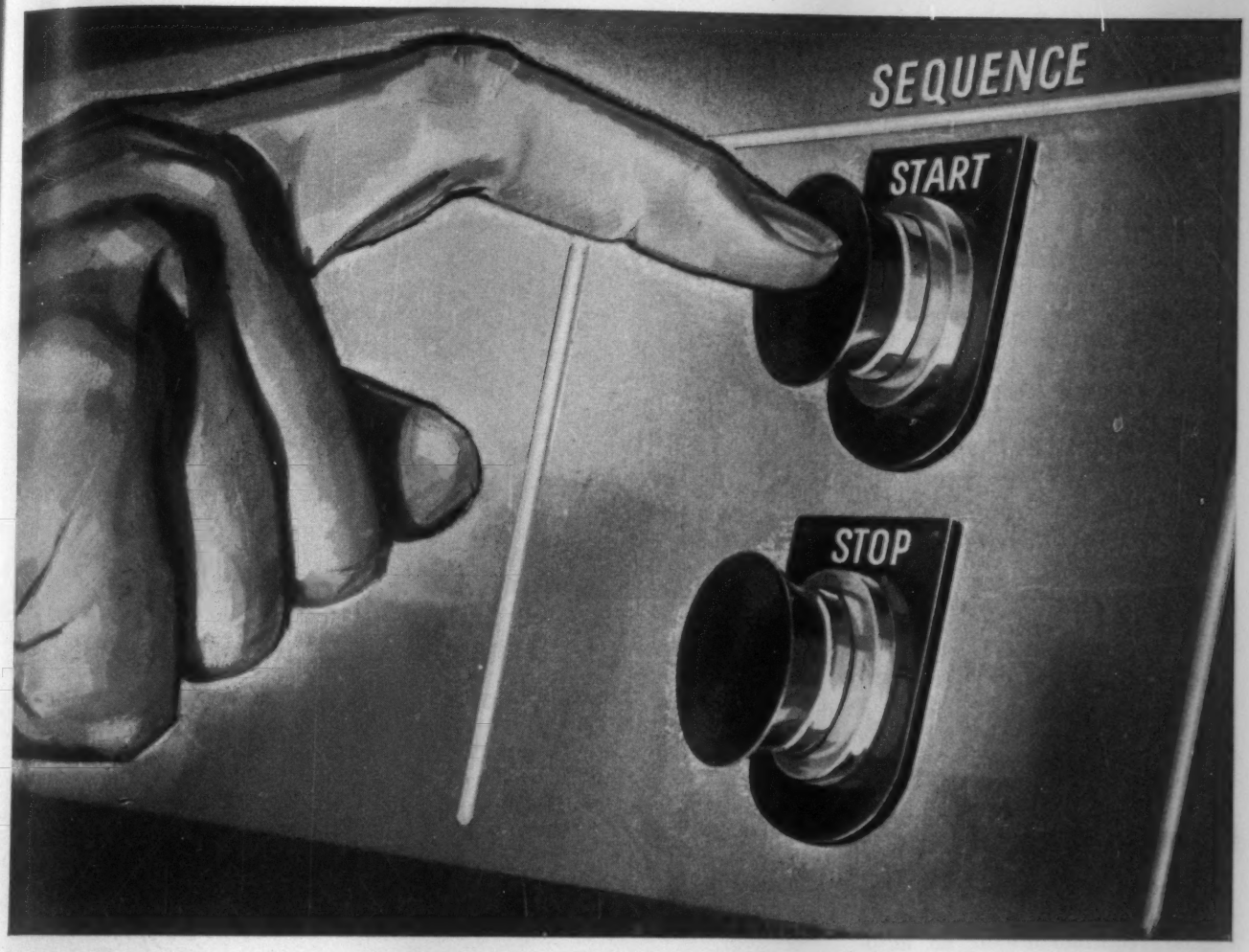
up to ten digits of input data in individual columns on the same line is provided by shuttle carriage of versatile digital readout unit. It may be programmed to add to a maximum of 11 digits, subtract, subtotal, total, list only on a non-add basis, and has the credit balance feature. The 12½-inch wide carriage will automatically shuttle between two columns. Single plug-in type connector controls both data input and operating functions. **Industrial Electronic Engineers**, 3973 Lankershim Blvd., N. Hollywood, Calif.

Circle 428 on Inquiry Card



Storage Feed Hopper

Designed for heavy parts and bar shapes, automatic storage feed hopper automatically orients and feeds bar shapes and parts from its large storage bin (5-ton capacity) to furnaces, presses, secondary operation, washing machines, etc., at production rates of 1000 pieces per hour. Hopper capacity is 35 cu ft or 10,000 lb. Controlled flow of oriented parts is automatically fed to processing equipment without operator assistance. Illustrated unit feeds 1¾-

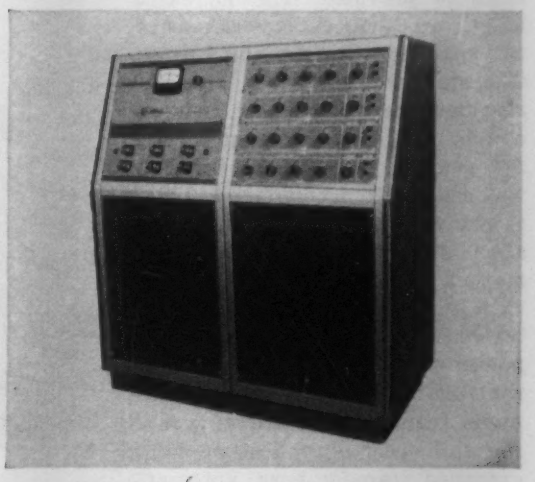


Got a job for the Batchetron?

Here's what it will do. Operating electronically from a remote control station, the Fairbanks-Morse Batchetron can be preset with knobs and buttons to assemble accurate quantities of dry and liquid components from any one or more bins or tanks. The cycle of mix is also preset, and the actual batching takes place at the touch of a button.

Which of these features will improve your batching operation? Do you want remote control—for instance, batching from an air-conditioned office? Do you want the fast programming feature—for the occasional single batch from a different formula? Do you want the automatic cycling—that will duplicate the batch again and again at the touch of a button?

The Batchetron is . . . Fairbanks-Morse electronics instrumentation plus accurate weighing in the Fairbanks-Morse tradition. There is a new bulletin, No. ED-14, on the Batchetron with many suggested applications which may fit your process operations. Send for it today. Fairbanks, Morse & Co., Dept. A-9, 600 South Michigan Ave., Chicago 5, Illinois.



Batchetron control console.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

SCALES • PUMPS • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

Circle 584 on Inquiry Card

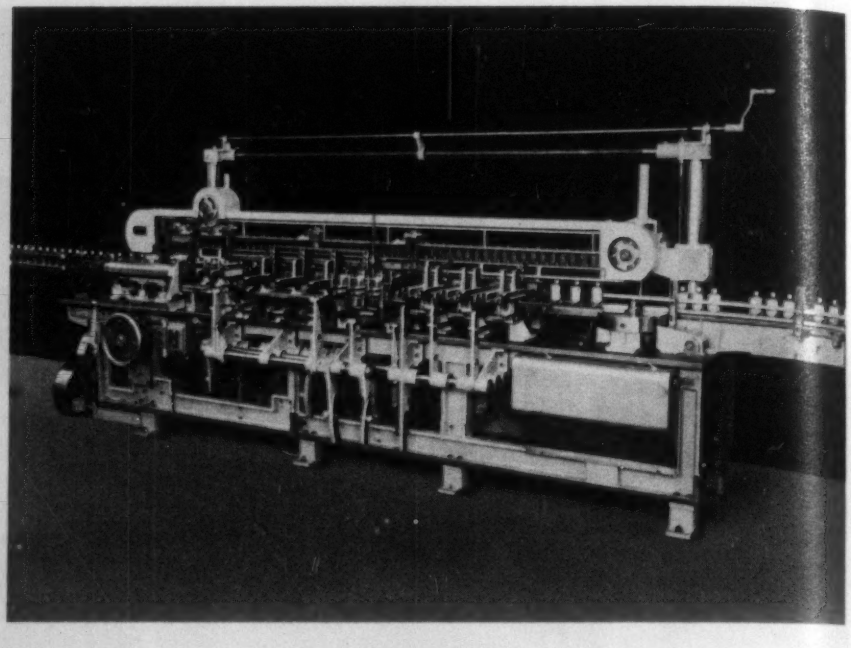
inch diameter by 8-inch long heavy wall tubes to a finishing machining line at the rate of 360 tubes per hour. Storage bin holds enough tubes for 8 hours of continuous production. Tubes are delivered from the storage bin to the short feed tray at the right of the machine. Flow of tubes from the storage bin is controlled electrically by the number of tubes at the feed tray. The processing machines are fed directly from the feed tray. Drive for the chain, which picks the tubes out of the storage bin, is located on the far side of the machine. **Campbell Machines Co.**, 18634 Fitzpatrick, Detroit 28, Mich.

Circle 429 on Inquiry Card

Extended Transfer Base

Called the Trans-O-Mator, new extended transfer base meets the special requirements of an automotive components manufacturer. By combining the frames of two standard units, normally 32 inches wide by 11 ft long with 40 usable stations, a machine 64 inches wide by 30 ft long with 88 usable stations is provided. The increased length was achieved by increasing the span between the end frames. One standardized power transmission unit, including motor, reducer, clutch, brake and company drive for smooth, high speed indexing was utilized to accomplish a 9-inch stroke with a transfer time of 1.3 seconds for a load up to 30 lb per station. Standard control panel, with an electrical interlock system between the indexing and tooling power supply, start, stop and jog controls, and provisions for automatic scanning of stations is used for the special application. With extended transfer base, automatic steering gear couplings are assembled at a rate up to 3600 pieces per hour. **Ferguson Machine & Tool Co.**, Roller Gear Div., P. O. Box 5841, St. Louis 21, Mo.

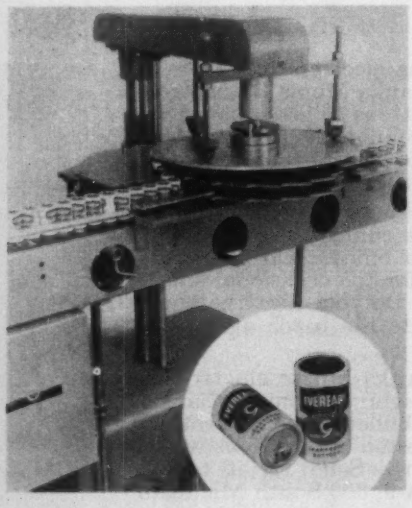
Circle 430 on Inquiry Card



Automatic Bottle Labeling Machine

Designed for automatic application of front or both front and back spot labels at speeds up to 180 containers per minute, automatic machine has simplified straight through intake with dog chain transfer which feeds three bottles at a time directly into intermittent carrier mechanism of machine. Adhesive is stenciled onto the container and affixed labels are wiped down at two pressing stations. Side take off of the finished bottles is eliminated through use of dial plate which transfers container from intermittent chain carriers onto continuous block chain discharge conveyor. Machine operates at 60 cycles per minute, and handles containers of less than 3 inches in width. Bottle labeler is powered by variable speed drive with 2 hp motor furnished. **Pneumatic Scale Corp. Ltd.**, Quincy 71, Mass.

Circle 431 on Inquiry Card



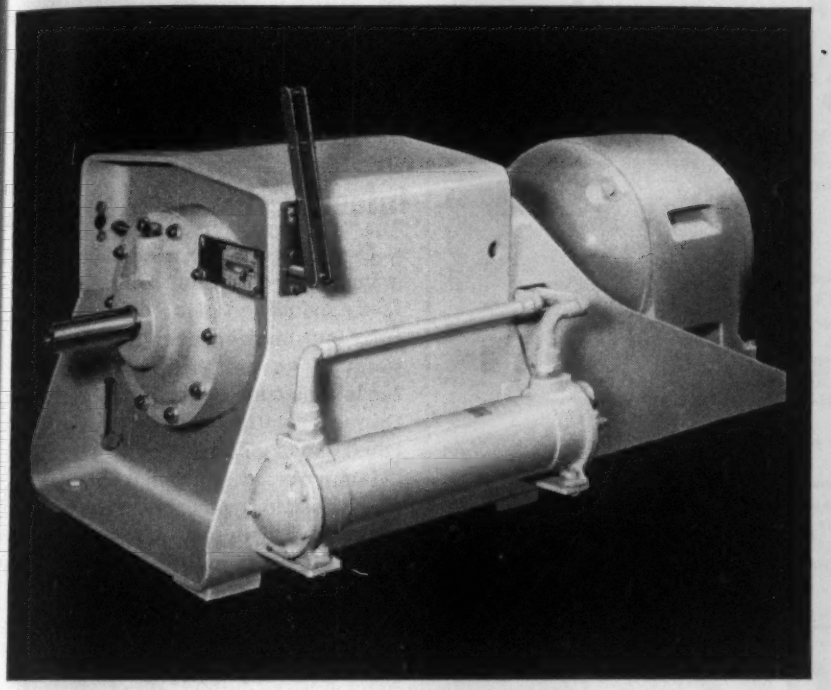
Battery Printer

Retail prices and codes are imprinted on the bottom of single-cell flashlight batteries as an integral production line operation with portable imprinting machine. Batteries are price marked and coded automatically as they are conveyed along a line.

Imprinting unit, called Model TB Markocoder, is fully automatic and operates at variable speeds up to 600 impressions per minute. Machine is portable, specially designed to permit its adaptation to any line in the plant without necessitating modifications to existing equipment or sequences. In operation, the Markocoder directs the flow of batteries through its imprinting section by means of a star wheel, returns them imprinted to the conveyor to continue their normal travel. Machine makes clean, permanent, precisely located imprints, and functions without affecting product travel speed. **Adolph Gottscho Inc.**, Hillside 5, N.J.

Circle 432 on Inquiry Card

Gýrol® Fluid Drives limit torque to give you a built-in safety factor!



Type VS, Class 2 Gýrol Fluid Drive is available in ten sizes, 1 hp to 800 hp, speeds to 3600 rpm.

The American Blower Type VS, Class 2 Gýrol Fluid Drive not only offers adjustable, stepless speed control, but its inherent shock-absorption ability protects machinery.

For, a Gýrol Fluid Drive will limit the amount of torque which can be transmitted under overload conditions. This torque-limiting capacity can be adjusted by merely positioning the speed-control lever.

What's more, Fluid Drive permits the motor to come up to speed under almost no-load conditions—allowing simplification of motors and starting equipment for heavy starting loads.

You'll discover many more important benefits for a wide variety of industrial applications by calling our nearest branch.

FEATURES

- Can be reversed while in motion by reversing motor
- Across-the-line starting on many applications
- Motor can reach full speed before engaging load
- A compact, self-contained unit
- Trigger-action response — adjustable speed
- Speed may be controlled manually or automatically

Speed control for the paper and textile industries

Papermaking and processing machinery needs smooth starting to prevent tearing; adjustable speed to adjust machinery to humidity, paper thickness; no-load starting to keep power requirements down. Fluid Drive is the practical answer. It meets these problems easily – and without excessive maintenance. In the same manner, textile machinery needs accurate speed control to give maximum production rates within safe limits for the yarn. Again the answer is Gýrol Fluid Drive. Consult our nearest branch office or write us for information.

American Blower products serve industry

- AIR CONDITIONING, HEATING, VENTILATING EQUIPMENT
- MECHANICAL DRAFT EQUIPMENT
- INDUSTRIAL FANS AND BLOWERS
- CENTRIFUGAL COMPRESSORS
- GYROL FLUID DRIVES
- DUST COLLECTORS
- REFRIGERATING MACHINES

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American-Standard

AMERICAN **BLOWER**

For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***WRITE** for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-923.

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

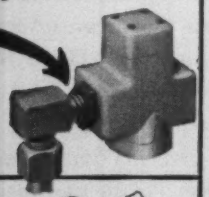
Pioneers in pneumatic timing.

Circle 586 on Inquiry Card

TRU-O-SEAL TEFLON SEAL

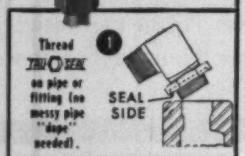
PAT. PENDING

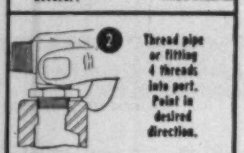
STOPS PIPE THREAD LEAKS instantly!

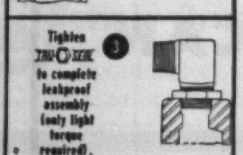


Prevents future leaks!

TRU-O-SEAL does away with messy pipe "dope" compounds, eliminates damage caused by overtightening of conventional leaky joints, and is immune to ALL known hydraulic fluids and to steam, air, water, solvents, and practically all gases and chemicals. It withstands temperatures from —100° F. to plus 500° F., saves cost and labor of special or welded fittings, and has been fully field tested and proven by leading manufacturers. Comes in ⅛" to 2½" pipe thread sizes.







Write for data and prices

TRU-O-SEAL DIVISION
Flick-Reedy Corporation

2015 N. Hawthorne Melrose Park, Ill.

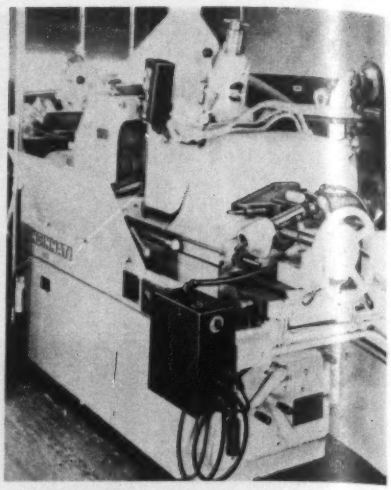
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

We invite you to see Our Exhibit at

BOOTH #1623
METAL SHOW
Oct. 8-12

PUBLIC AUDITORIUM CLEVELAND

Circle 587 on Inquiry Card



Infeed Grind Attachment

Designed to increase centerless grinding production, automatic infeed grinding attachment offers fully automatic pushbutton operations. The unit automatically infeeds and times spark-out, returns to open position and ejects the finished part. Called Feedcision, the attachment is equipped with variable position positive stop, controlled by one set screw for removal of grinding stock from 0.005 to as much as 0.040 in one grinding cycle or pass.

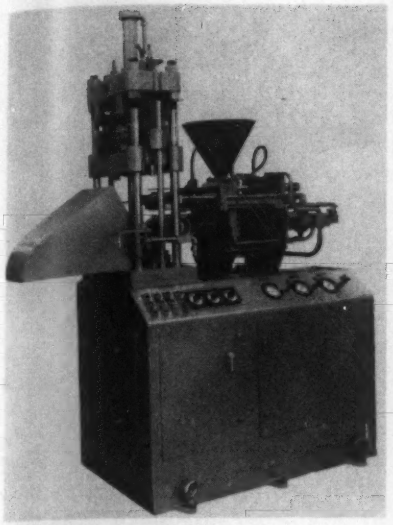
The operator's hands do not come near the grinding wheels. In addition, a red safety caution lamp glows while the machine is in setup position and also while in the grinding cycle. In grinding very small diameters (0.005 stock removal) Feedcision opens only 0.007 so that very small diameter workpieces cannot get caught between regulating wheel and workblade, thereby protecting materials and machinery.

The device has no cams or slides, resulting in very little wear on both the machine and the attachment. With Feedcision, the nut on the infeed screw moves only the minimum distance for the amount of stock removal. The pushbutton control station and control cabinet are oil-tight sealed. **Modern Devices,** Box 429, Libertyville, Ill.

Circle 433 on Inquiry Card

Injection Molding

Vertical clamping and horizontal combing are provided by 2-oz, fully automatic injection molding ma-



chine. With this clamping and combing combination, degated parts can be ejected horizontally onto a conveyor instead of being dropped into bins, reducing the danger of damage to the surfaces of finely modeled decorative pieces. Barriers can be incorporated into the horizontal comb to guide the separate pieces of a multiple-piece mold into separate bins, as well as the sprues and runners.

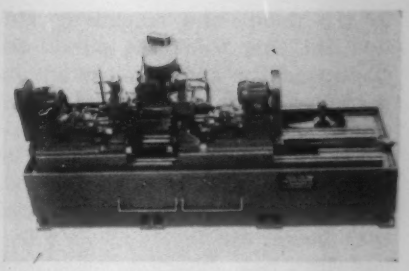
Vertical configuration of the new machine also simplifies mold setup and makes easier the handling of inserts under semiautomatic operation. Either top or bottom ejection of the molded pieces is possible, due to the incorporation of top hold-down pins, top knock-out pins, and bottom knock-out pins. Hot runner molds provide positive shutoff at the mold. Positive shutoff at the injection nozzle is also incorporated in the design, permitting the molding of nylon without stringing, and without nozzle change.

Some typical applications of the machine are in dashboard knobs and dials, and control lever handles for automobiles; pushbuttons, control knobs and dials for appliances; keys and lever handles for business machines; nylon industrial gears and cams, etc.

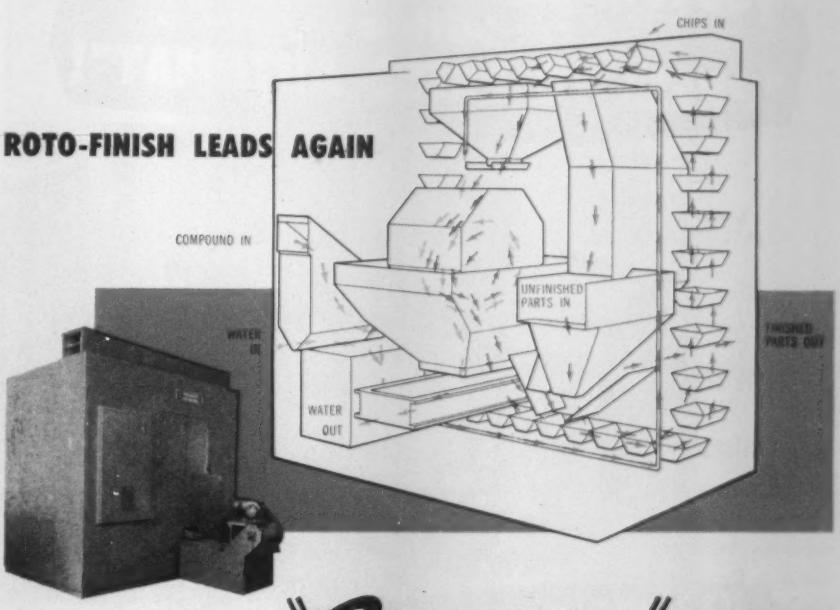
Model 701 machine has an automatic cycle of only 3.5 seconds from the time the mold opens until it starts to fill again. Injection molder is completely self-contained, requiring only 18 sq ft of floor space. **F. J. Stokes Corp., Plastics Div.,** 5500 Tabor Rd., Philadelphia 20, Pa.

Circle 434 on Inquiry Card

Double-End Transfer Unit



Automatic stock cut-off simultaneous with double-end machining is combined in a new transfer machine. Unit embodies automatic feed for bar stock to a circular saw cut-off station, and transfer facilities to two opposed secondary machining heads. Stock is fed to the stock stop which is set for a predetermined length and is retained in a vise during the cut-off operation and also in two transfer carriers. The transfer mechanism consists of two continuous chains to which the carriers are fastened. The cut pieces are indexed forward



ROTO-FINISH LEADS AGAIN

the new "Rotomation" MACHINE

MAKES MECHANICAL TUMBLING A FULLY AUTOMATIC BARREL FINISHING PROCESS

- Completely Automatic
- Needs no operator in attendance
- Loads and unloads itself with each cycle.
- Cycle variable for different part requirements.
- Provides continuous operation
- Assures uniformity of finish
- Low cost operation — high production
- Complete package unit
- Simple to install . . . Electric, water, air and drain connections only.
- Suitable for straight line production.
- Thus, "Rotomation" barrel finishing machine becomes a machine tool.

Roto-Finish COMPANY

3742 MILHAM ROAD, KALAMAZOO, MICH.

P. O. Box 988 – Phone 3-5578

ORIGINATORS OF THE ROTO-FINISH PROCESS

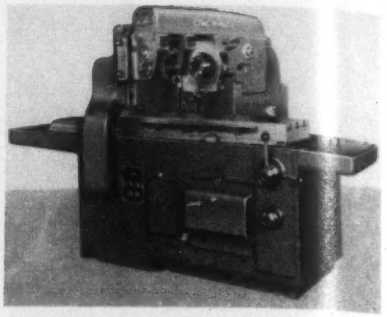
Circle 588 on Inquiry Card

to the double-end machining station. At this point the pieces are positioned for endwise location by hardened shoes and lifted from the carrier by self-centering, self-equalizing clamps and held during the double-end machining operation. Box mill turning can be combined with center drilling and chamfering. Two basic machine sizes give capacity of ¼ to 1½ inches and 1 to 4 inches diameter tubing or solid stock. Magazine stock loading can be furnished. **Motch & Merryweather Machinery Co., Manufacturing Div.**, 888 E. 70th St., Cleveland 3, O.

Circle 435 on Inquiry Card

Milling Machines

Powermatic is the name of a new line of automatic milling machines which are built in plain, duplex and plain rise-and-fall styles. The units offer increased cutting capacity (up to 10 hp) and higher spindle speeds (up to 3000 rpm) for taking conventional milling or



climbing cuts with either high speed steel or sintered carbide milling cutters.

Designated the 200 Series, the millers are built in seven sizes of each style, from 24-inch table travel, 5 hp, to 96-inch table travel, 10 hp. Automatic cycles and manual maneuverability have been combined for the production type machines. Through a cycle selector unit, a single lever initiates the complete milling operation, including automatic table cycle, automatic spindle stop, automatic backlash eliminator, automatic spindle carrier cycle of rise and fall machines, and automatic spindle retraction when this equipment is supplied.

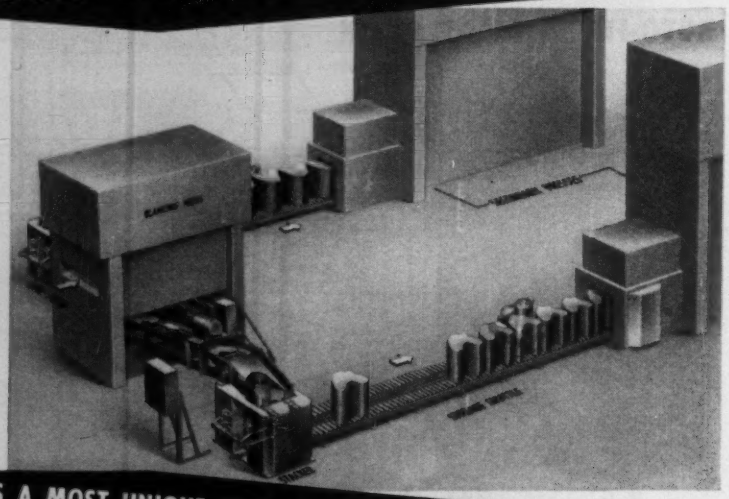
The walls of the bed are wider than the table, and the intervening space serves to catch the coolant and chips and direct them to a compartment. Table ways are automatic pressure lubricated with filtered oil. Standard automatic table cycles feed to the right or left, or alternately right and left with a center stop position for safety. Rapid traverse is at the rate of 300 inches per minute. Choice of three spindle speed ranges is available: 75 to 3000 rpm, 50 to 2000 and 30 to 1200 rpm. **Cincinnati Milling Machine Co.**, Cincinnati 9, O.

Circle 436 on Inquiry Card

Shaft Straighteners

Shafts are prepared for centerless grinding by automatic straightening machines which handle 600 pieces per hour. Synchronization with the grinders is not necessary because a 30-part storage chute automatically starts and stops the straightener as parts are demanded by the grinder line. Straightness is held to 0.0015-inch total indicator reading. Out-of-

you can eliminate tote boxes... with a "PRESS-TO-PRESS AUTOMAT"!



IT'S A MOST UNIQUE SYSTEM: Shuttle automatically feeds and stores blanks—NO gaps in the line.

CHAIN CONVEYOR: It carries blanks, from the blanking press, to the stacker.

AUTOMATIC STACKER: Its cycle is controlled by the height of the stack. Gates are air operated and actuated by limit switches. A springloaded cam on the center shuttle bar, when actuated, permits a pusher dog to go into operation—pushing the stack, from the stacker, to the storage shuttle. During the unloading operation, new blanks entering the stacker, are held in preload position by retractable fingers. It's fully automatic!

STORAGE SHUTTLE: It's a storage space for the stacks, while they await their turn to be fed automatically to the secondary presses. And it's operated by a motor and a reducer, mounted beside the shuttle bar. It can be built to any desired length.

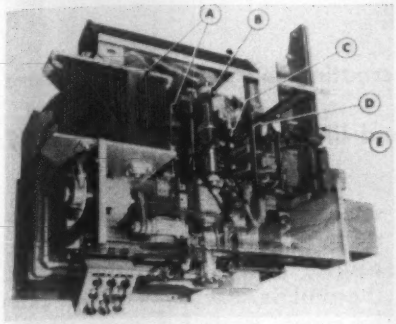
THE OUTSTANDING FEATURE: The chain conveyor, and the storage shuttle, are separately operated. Therefore, downtime on one press never interferes with the production on the other presses.

MPE **MICHIGAN PRODUCTION ENGINEERING CO.**
Engineering and Manufacturing
1796 E. 9 Mile Road • Hazel Park, Michigan

Circle 589 on Inquiry Card

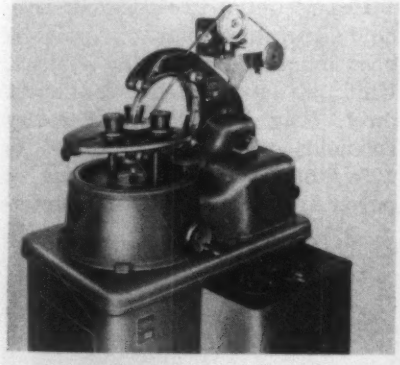
straightness up to 0.125-inch total indicator reading at center can be accommodated.

In the overhead view illustrated, shafts are fed from a loading and storage hopper (*A*) to a walking beam conveyor which carries them to the straightening station (*B*).



Here, rolls apply a programmed load at the shaft center while the shaft is rotated. A gaging station (*C*) checks the straightened shafts. Reject mechanism (*D*) removes those outside tolerance. The conveyor advances those within tolerance to the feeder (*E*) which serves the following operation. **Cargill Detroit Corp.,** 2254 Cole Ave., Birmingham, Mich.

Circle 437 on Inquiry Card

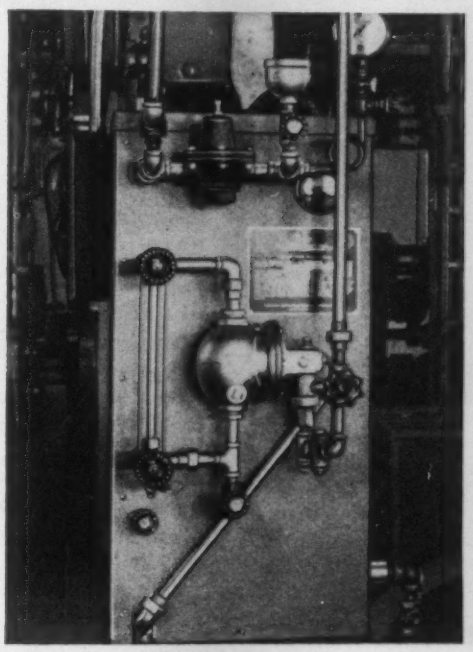


Toroidal Tape Winders

Series of automatic tape winding machines is designed for use in the toroidal coil field. Machines feature a core-turning table with automatic feed and variable pitch control, automatic tape cutting device and special manual feeding attachment for hand winding when desired. The series incorporates three models: U-9, U-14 and U-20, to wind tape from 3/8 to 1 inch. **Universal Mfg. Co.,** Hillside, N. J.

Circle 438 on Inquiry Card

Pantex Speedylectric Steam Generator



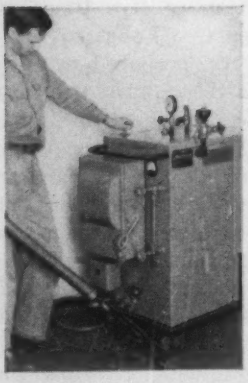
UL Listed
ASME Code

Ideal Steam Source for Pilot, Lab and Test Work

permits precise control of pressure and quality . . . eliminates operator, odor, fumes, fire hazard

Industry uses this "extra" steam boiler in many ways to facilitate production, reduce costs and eliminate fire and explosion hazards. For pilot operations, laboratories and tests the Speedylectric Steam Generator often proves the only answer to steam needs.

It can be installed right in a laboratory, for it requires little space and practically no attention or maintenance. It is silent, odorless, free from fumes and hazards of fire or explosion. It exactly and automatically maintains any desired pressure, and constant quality 98 per cent dry steam. Utilizing the Speedylectric electrode principle, it generates steam electrically, at surprisingly low cost. Capacities from 2 to 60 Bhp; 15 to 500 Psi; for 220, 440, 550 volts AC. USE COUPON to get complete details.



Speedylectric Steam-Jet Cleaner lets one man do the work of five. High pressure jet of dry steam and solvents quickly removes grease and dirt accumulations from machines and equipment *without* flooding floors. No need to stop nearby production or move machines outside. Completely safe and portable.

PANTEX MANUFACTURING CORPORATION
Box 660AI, Pawtucket 9, R. I.

Send me facts and figures on:

☐ Pantex Speedylectric Steam Generator
☐ Pantex Speedylectric Steam-Jet Cleaners

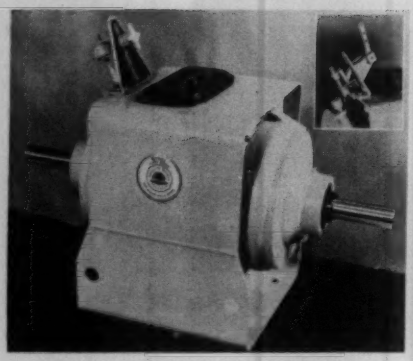
Name and Title .....
Company .....
Address .....

Circle 590 on Inquiry Card

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

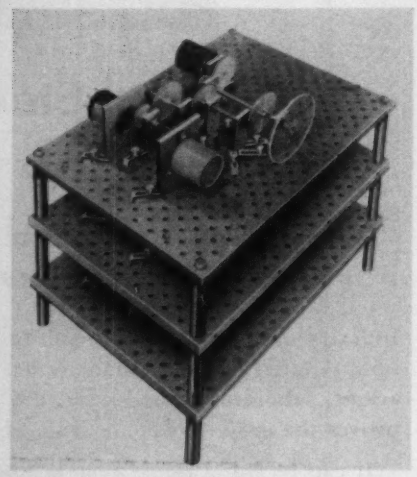
For detailed information and literature, use card page 17



Fluid Drives

Well suited for automated installations where minimum maintenance, automatic speed adjustment, and positively uniform accuracy of repeat speed settings are prime considerations, Class 2 adjustable speed Gyrol fluid drives are designed for 1 through 25 hp applications. Being adjustable speed fluid drives, the units protect drive motors and driven machinery from shock loads, torsional vibration and excessive torque. They can be used with a conventional single-speed electric drive motor to provide adjustable, stepless speed control. Speed adjustment can be manual or automatic. Where a two-directional motor is used, the fluid drive and load can be reversed while in motion by merely changing motor rotation. Fluid drives are self-contained units. All moving parts are continually bathed in large volumes of oil. Output shaft speed is altered during operation by varying the amount of oil in the fluid drive's working circuit. Working oil level is controlled by a sliding scoop tube mechanism which is readily adapted to any known method of automatic actuation. Entire working circuit is enclosed within a housing which also serves as the oil reservoir. Both the input and output shafts are supported by two radial roller bearings. A chain driven turbine pump, integral within the unit, circulates oil to the working circuit. **American Blower Corp.**, Detroit 32, Mich.

Circle 439 on Inquiry Card



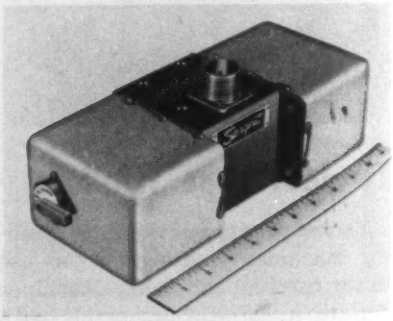
Servocontrol Assembly Kit

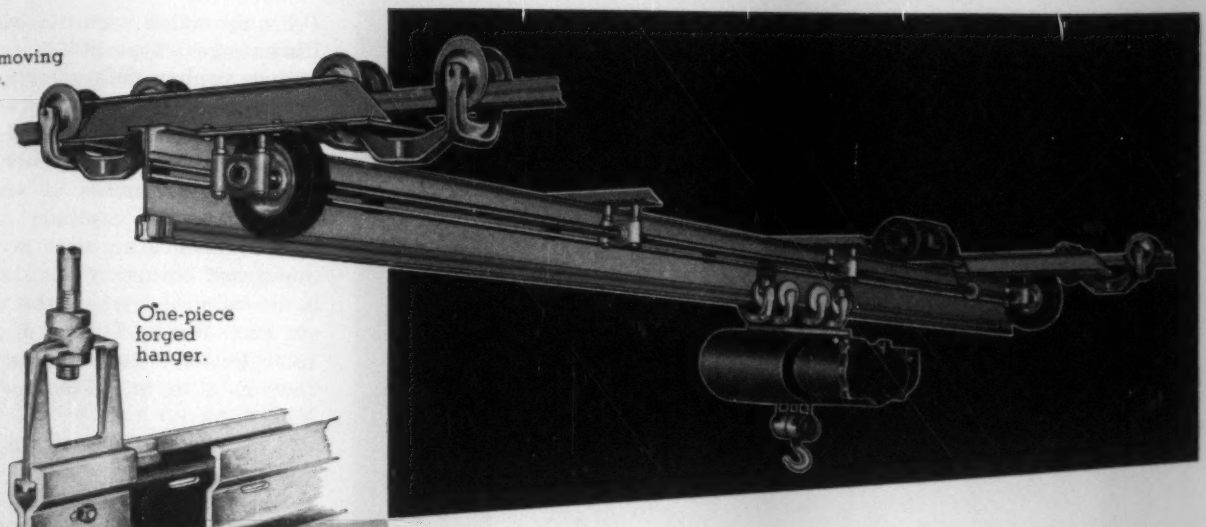
Designed for developing servocontrol systems by arranging a breadboard setup for tests, new assembly kit has been revamped by the addition of five times as many new parts. Fourteen component hangers, prebored to various sizes, make mounting easy for most electrical components, and four blank hangers may be bored to take care of the remainder. Gears are available as split hub type. Adapter gears, mitre gears, bevel gears and antibacklash gears have been added to the list of components. Bearing hangers, dial assemblies, magnetic clutches, shaft adapters, couplings, terminal assemblies, a handcrank, a differential, and inertia load disks are included. Called the Servoboard, the unit is now available in three kit types: Basic Kit Model 1111 to meet the needs of simple arrays, occasional use and university laboratory budgets; Standard Kit Model 1112 to satisfy the general requirements of average use; and Master Kit for situations where many projects are underway. **Servo Corp. of America,** 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Circle 440 on Inquiry Card

Hydraulic Valve

Heavy duty, two-position, solenoid controlled hydraulic valve is used in missile launching systems. Unit is actuated by continuous duty, long life, balanced rotary solenoids and operates on 95 to 125v, 60 cycle, single phase ac power. Valve has no reciprocating components. All moving parts are rotary and dynamically balanced. Valve is equipped with moisture proof housings and can be left continuously energized in 165F ambient. Shaded poles are used to reduce ac hum. Valve is supplied with manual override and is manufactured in two configura-





Free-moving crane.

One-piece forged hanger.

Twin section track.

Overlapping splice.

Rugged switch construction

Compact electrification

Automatic dispatch carrier.

TAILOR-MADE SYSTEMS
FROM STANDARD PARTS

Standard American Monorail units offering the many advantages illustrated, are combined into systems for handling any type of unit loads.

These systems are available for manual, electric or automatic operation with local or remote control.

Experienced Monorail engineers will tailor-make a cost-saving handling system from standard parts to fit your specific needs.

Write today for Bulletin C-1.

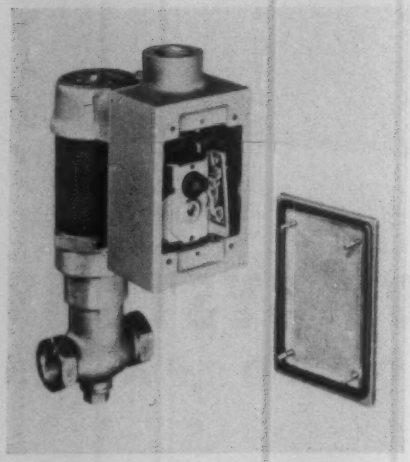
Member of Materials Handling Institute - MonoRail Association

AMERICAN OVERHEAD HANDLING EQUIPMENT MONORAIL COMPANY

13144 ATHENS AVENUE, CLEVELAND 7, OHIO (IN CANADA—CANADIAN MONORAIL CO., LTD., GALT, ONT.)

tions: Solenoid actuated both ways and solenoid actuated, spring return. Capacity is 1.5 gpm at 200 psi total pressure drop. It operates in ambient from −20 to 165F in 1500 psi or 3000 psi hydraulic systems. **Sargent Engineering Corp.**, 2533 E. 56th St., Huntington Park, Calif.

Circle 441 on Inquiry Card



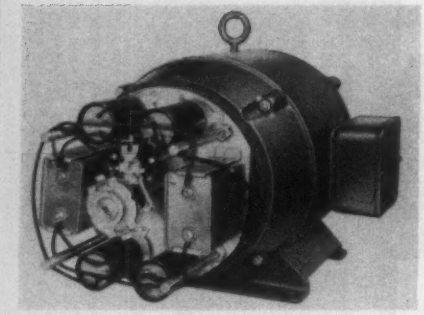
Timer Valves

Flow of liquids, gas or air can be controlled automatically with new timer valves. Units consist of a solenoid valve and a timer control sealed in a water tight case. Timer valves turn the flow on or off at desired time intervals. As they are available in a wide variety of timing cycles, they have numerous industrial applications. For example, timer valves can be used to turn a flow either on or off, or both on and then off, at any desired time. They can perform this function each day with repeat cycle operation — no resetting is needed. Timer valves can also be used to obtain continuously intermittent operation. New valves fit all standard pipes ⅜-in. and larger, and operate on 110 or 220 v., 60 cycle current. **Automatic Controls Corp.**, 2390 Winewood, Ann Arbor, Mich.

Circle 442 on Inquiry Card

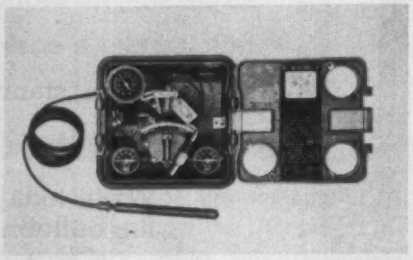
All-Weather Motors

Especially suited for use in the oil country, farm equipment manufacture, and small industry as well as in outdoor plants, new high torque, capacitor start, capacitor



run motors are available in 1725 and 1140 rpm speeds. Designed for applications requiring more than 7½ hp single-phase operation, three new motors — two rated at 10 hp and one at 15 hp — have been added to line of all-weather, capacitor single-phase motors. The motors have rodent-proof housing — screens in the end head openings seal the motors against entry of large objects. External mounting of condensers and centrifugal switch mechanism in weatherproof covers yields quick and easy inspection even while the motor is operating. The prelubricated ball bearings are sealed against grain dust and other foreign matter. All steel parts are protected by a special moisture and rust resistant undercoating. Other motors in the line are ¾, 1, 1½, 2, 3, 5, and 7½ hp models. **Robbins & Myers Inc.**, Springfield, O.

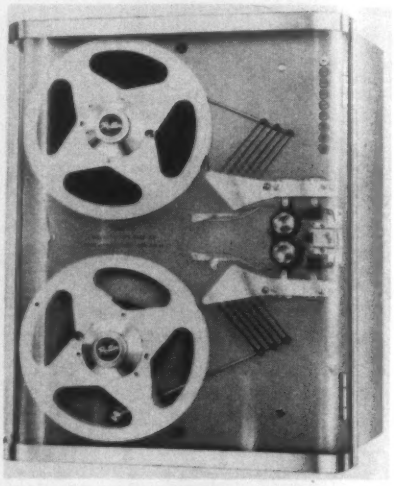
Circle 443 on Inquiry Card



Temperature Controller

Positive fluid flow control through diaphragm operated valves, based on temperature variations, is provided by Type 1460 temperature controller. Equipped with an external vapor-tension thermal system to actuate the power unit in the pilot, the temperature controller offers a choice of temperature ranges. By simple adjustment, it permits either 100 per cent throttling action or *On-Off* snap action within a wide limiting range. Type 1460 is equipped with a copper bulb attached to 8 ft of copper capillary protected by a double sheath of braided copper wire. Tubing is further safeguarded by 3 inches of armor at each end of the capillary. A temperature indicating dial, set in the upper left corner of the controller is an integral part of the thermal system. **Black, Sivalls & Bryson Inc., Product Information Dept.**, 7500 E. 12th St., Kansas City 26, Mo.

Circle 444 on Inquiry Card



Magnetic Tape Handlers

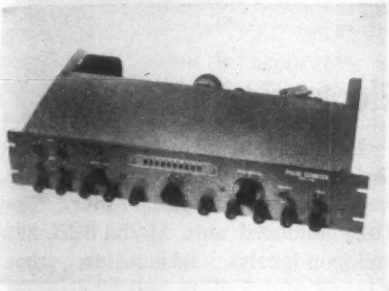
Available as individual components or in complete digital data handling systems to satisfy specific computer, industrial and business applications, Model 905 digital magnetic tape handlers are capable of tape speeds up to 75 inches per second with 3 millisecond starts and stops. Tape widths of ¼, ½, ⅝, ¾, 1 and 1¼ inches may be used. Other features of the tape handlers include fast rewind in both forward and reverse directions, requiring 2½ minutes to rewind 2400 ft of tape. Handler is designed for rack mounting; the transport mechanism is mounted on a hinged panel which provides access to all mechanical parts and tubes. Hinged rear door provides access to all wiring connections and the remote control terminal strip.

Quick threading is facilitated by a mechanical arrangement that retracts tension sensing arms, permitting changing of tapes in sec-

onds. Unit is automatically stopped when the end of a reel of tape approaches, when line voltage fails or drops below a prescribed minimum, or in the event of a tape failure. All machine functions may be controlled by front-panel pushbuttons or by remote contact closures or pulses.

Standard models are available with two tape speeds in the ratio of 4 to 1, with higher speeds of 30, 60 and 75 inches per second. Multiple channel record playback heads and amplifiers for recording and playing back from two to 14 channels of information are available as optional equipment. **Potter Instrument Co.,** 115 Cutter Mill Rd., Great Neck, N. Y.

Circle 445 on Inquiry Card



Variable Scale Counter

Applicable to any counting need, whether it be for a preset counter, a burst counter, a scaler or an adder, Type 1750 variable scale counter features a better method of displaying the count in a digital system as well as improved operating characteristics. Each count is represented visually by means of a neon indicator and electronically in the form of a dc signal, thereby allowing the unit to act as a sorter, a pulse distributor, a converter or a coding device. Counter input accepts 0.1 microsecond, 30 v pulses, amplifies and standardizes them, and then applies these pulses to the grids of a Burroughs beam switching tube where they are counted at speeds from pushbutton to 500 kc. The beam switching tube, where the count is stored, has ten stable beam positions. The output of each of these positions is available in the form of a dc voltage pulse, 90 v from the position on which the beam is formed, 60 v from the other nine positions. Scale factors of two through ten

Its One Objective: To produce new product-handling savings—for you!

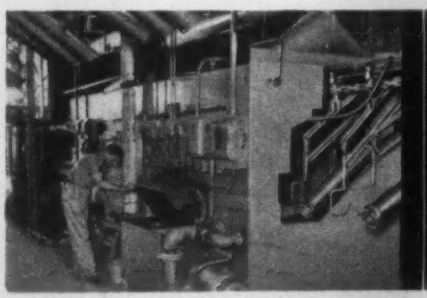
WILLIAM HENKE, able veteran of 20 years with our engineering staff, has helped to engineer every type of conveying system for every type of industry.

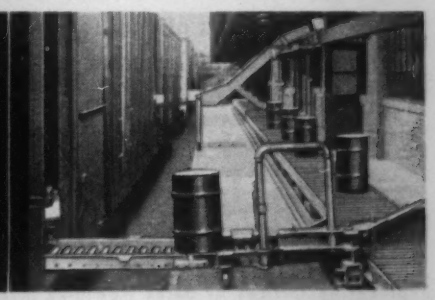
JIM RAKEL, one of our brilliant young "Co-op" engineers from University of Cincinnati, wasn't born in 1901—when A-F built the *first* conveyor and pioneered the automatic assembly line.

But daily, since that year, predecessors of our young Rakel have conferred with men like Henke—to fuse daring new efficiencies with sound judgment—to make substantial economies in the in-plant movement of parts . . . products . . . cartons . . . cases . . . barrels.

And, because A-F is unique among all manufacturers in being able to design, build and install a *plant-wide completely coordinated cleaning, processing and conveying* system—as well as offer low cost, but efficient, pre-engineered sections of roller, wheel, belt and trolley conveyors—all based on 55 years of experience—you can be sure that whether your plant is gearing for complete automation or is taking the first steps toward a single conveyor system, our company can help solve your handling problems.

Write us—today.





YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

A-F

A-F *ENGINEERED* Conveying Systems

Also Pre-Engineered Conveyors—
Wheel, Trolley, Roller, Belt
Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 173 Disney St., **CINCINNATI 9, OHIO** and Azusa, California

Circle 592 on Inquiry Card

Geared TO MEET INDUSTRIES' DEMAND FOR HIGH QUALITY CONVEYING MACHINERY

Typical Mathews truck-haul system designed to provide continuous flow warehousing.

Whatever the conveying problem might be—whether it involves the handling of a few pounds or many tons —**Mathews** builds the equipment to do the job. You can be sure of this service, from proposal through installation, when you buy **Mathews Conveyers.** And, of course, you get the benefit of over **fifty years' experience** in continuous flow material handling.

50 YEARS OF MC MECHANIZED HANDLING

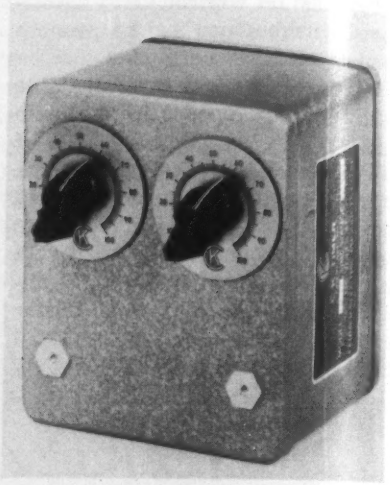
MATHEWS CONVEYER COMPANY
GENERAL OFFICES . . . . ELLWOOD CITY, PENNSYLVANIA
PACIFIC COAST DIV., MATHEWS CONVEYER COMPANY WEST COAST, SAN CARLOS, CALIFORNIA
CANADIAN DIVISION . . MATHEWS CONVEYER COMPANY, LTD. PORT HOPE, ONTARIO
Engineering Offices or Sales Agencies in Principal American and Canadian Cities
Export Representative—Foreign Trade Division of New York Hanseatic Corporation

MATHEWS

Circle 593 on Inquiry Card

are available by turning a knob. Provision is also made for automatic zero reset without cycling. **Burroughs Corp.,** Detroit 32, Mich.

Circle 446 on Inquiry Card



Electronic Timer

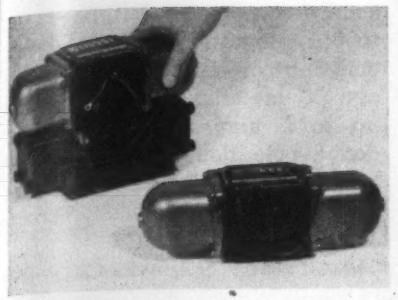
Independent adjustment for both *On* and *Off* cycles is provided in recycling electronic timer. The fully enclosed unit, Model 3CK, has independently adjustable time ranges of 1.5, 3, 6, and 12 seconds. It can easily be converted to single time cycle operation by the removal of one tube from the unit. Fully enclosed terminals are easily accessible by removal of back cover.

The timer features instant starting cold cathode tubes that require no warm up time; tube cut out during timed-out periods assuring long tube life; plug-in relays for easy servicing; 8-amp, single-pole, double-throw load contacts for 115 v ac operation. **Farmer Electric Products Co. Inc.,** 2300 Washington St., Newton Lower Falls, Mass.

Circle 447 on Inquiry Card

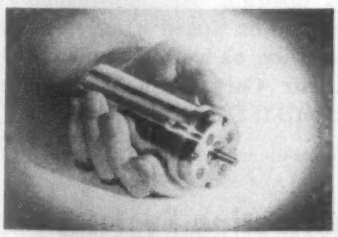
Directional Valves

Line of solenoid operated and solenoid controlled, pilot operated directional valves is designed for industrial oil-hydraulic systems. Ample room is provided in the valve body for making electrical connections, thereby eliminating the need for a separate conduit box. Available for gasket or subplate mounting, they are compact and require



a minimum of piping. Other features of the valves are an override plunger and a solenoid cover chain. The override plunger permits manual operation of the valve during setup operations, circuit checks, or failure of solenoid or current. The chain prevents loss of covers during solenoid maintenance or adjustment. Solenoid controlled, pilot operated valves in the new series are known as the DG-5 models, (left). This valve incorporates a solenoid operated pilot valve and a directional valve in a sandwich type unit. The DG-5 valves are available as four-way units for ¾-inch and 1¼-inch nominal and piping sizes. They can be obtained as single-solenoid spring offset models or with a double-solenoid, no spring or spring-centered design. Spool types may be open, closed, tandem center, or other combinations and modifications. Solenoid operated units in the new series are the DG-4 models (right). These valves are available as two-way or four-way units in ⅛-inch nominal size for ¼-inch piping size, and also in ¼-inch nominal size for ⅜-inch piping size. **Vickers Inc.**, Detroit 32, Mich.

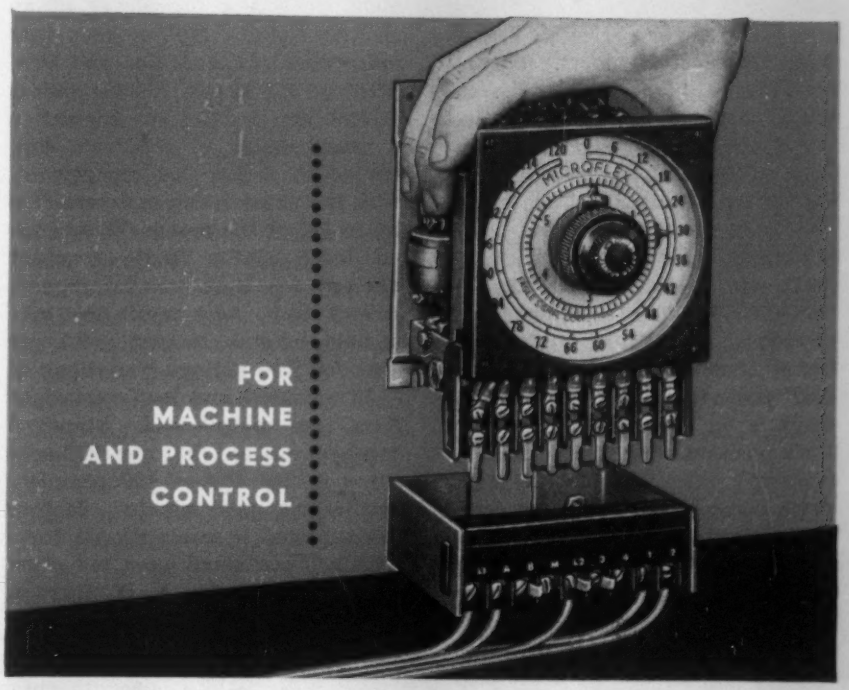
Circle 448 on Inquiry Card



Shaft Position Converter

Standard shaft position to digital converter system measures shaft positions to the desired accuracy and presents an output for recording in any desired digital code. A simple induction device,

EAGLE
Microflex Reset Timer



NOW . . . quick plug-in connection!

See that new-design terminal panel? Terminals are all in a row. So you can quickly and easily adapt the Microflex Reset Timer to plug-in connection. Simply use a Microflex Plug-In Kit, available in all accepted variations. You can even rotate the terminal panel for rear connection — (just loosen two screws) — without any rewiring.

Time settings of pinpoint accuracy are possible with the Microflex double dial. Through precision vernier action, one complete turn of the *inner* dial advances the *outer* dial just one division. That's a 20-to-1 ratio, made possible by a patented Microflex threaded axle and pinion. Accuracies are obtainable to 1/60 second. Over 150 timer operating combinations, plus a wide range of long or short time periods. The ideal timer for molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for FREE AUTOMATION BOOKLET and Bulletin 110.

MAIL COUPON TODAY

EAGLE TIMERS SAVE TIME . . . SAVE MONEY

EAGLE

SIGNAL CORPORATION
Industrial Timers Division
MOLINE, ILLINOIS

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. A-956
MOLINE, ILLINOIS

Please send FREE AUTOMATION BOOKLET and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

COMPANY

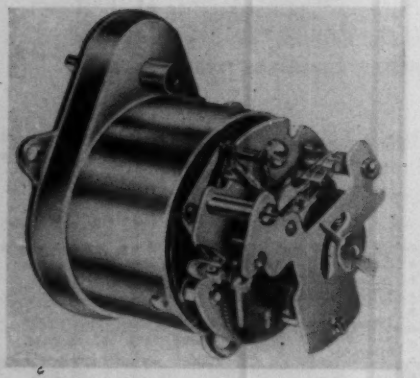
ADDRESS

CITY ZONE STATE

Circle 594 on Inquiry Card

the shaft position quantizer has no gears or digitizing commutators. Designed as a standard package, the quantizer is adaptable to any shaft. The four standard models, functioning with a standard control unit, divide one turn of the data shaft into any one of many possible divisions which range from 320 to 4096 parts. Usefulness of the quantizer may be extended by incorporating an additional standard device that identifies any one of a number of 360-degree turns of the data shaft. The total count is accurate to ± one count for any position of the shaft and is guaranteed whether the data shaft is stationary or turning at up to 240 rpm. An external command pulse initiates a shaft position reading. The output count is an exact measure of the shaft position at the instant of the command pulse. Manual or automatic command pulses may occur at regular or irregular intervals up to 20 readings per second. However, using special techniques, thousands of readings per second may be taken. Shaft velocity and acceleration, as well as shaft position, can be digitized using the same quantizer with other Austin standard components. These potentials extend the applications of the digital system. Other uses are in instantaneous monitoring, automatic reference recording, automatic data reduction and industrial process control. **Austin Co., Special Devices Div.**, 76 Ninth Ave., New York 11, N. Y.

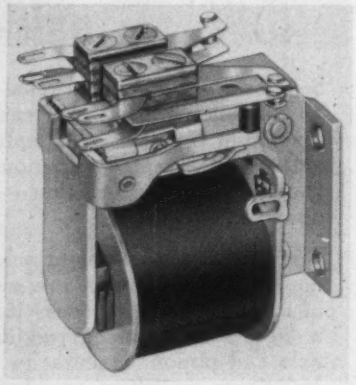
Circle 449 on Inquiry Card



DC Timing Motors

Designed for use in automatic controls, timers, time delay relays, repeat cycle timers and computers where the mechanism must do the work in driving charts or in operating contacts, cams and actuators, new series of chronometrically governed dc timing motors provide the accuracy of an escapement clock and the power of an electric motor. Motors keep rate independent of load, line and temperature variations. Power pulses at full line voltage are applied to a small motor at intervals controlled by a jewelled escapement, with the pulse duration determined by travel of the motor. This method holds motor travel constant during each time interval regardless of load. As a result beat rate is held constant within ±0.1 per cent for line voltage variations of ±20 per cent and load variations from zero to full load. Standard escapements are 300 and 900-beat types giving 150 or 450 complete oscillations per minute. Motors are supplied in conventional form with self-contained gear reduction and output shaft. **A. W. Haydon Co.**, Waterbury, Conn.

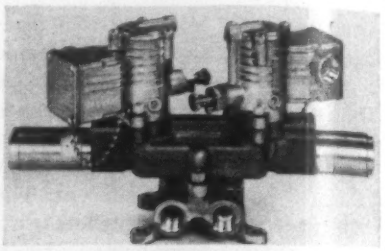
Circle 450 on Inquiry Card



AC Relay

Well suited for use in communications controls, microfilm apparatus, office machines, annunciator systems, etc., new relay is of modified telephone type design, offering the advantages of telephone type performance in an ac relay. It is cool operating, thus making it particularly suitable for use where hermetic sealing or dust covers are required. Typical heat rise in open air is 18C, using 4C up to 3 amp at 110 v, with 0.020 gap and 20 gram contact pressure. Coils can be supplied for all standard voltages up to 220 v ac. Contact combinations are six pole, double-throw up to 5 amp at average 7.5 va; four pole, double-throw up to 5 amp at average 3 va; double-pole, double-throw up to 10 amp at average 7.5 va. **Comar Electric Co.**, 3349 Addison St., Chicago 18, Ill.

Circle 451 on Inquiry Card



Valve Attachment

Power centered neutral attachment for all double-solenoid Valvair Speed King valves provides full control of double-acting cylinders and similar devices. New attachment, which consists of stop plungers in extensions mounted at the ends of the valve body, uses air power to provide positive mechanical centering of the main valve stem in neutral position. Completely self-contained within the valve assembly, the neutral operates without the use of mechanical springs on the main valve stem. Because it provides a positive mechanical stop at neutral and has no springs to weaken or break, the new attachment will not allow the main valve stem to drift out of neutral. Absence of springs also allows power-centered neutral equipped valves to be mounted in any position. Attachment may be installed on Speed King valves now in service, as well as on new valves. **Valvair Corp.**, 454 Morgan Ave., Akron 11, O.

Circle 452 on Inquiry Card

Lubricating Systems

Designed to withstand temperatures up to 500F while providing fully automatic lubrication, centralized lubrication systems use newly designed valves and filters that combine heat resistant qualities with desired filter and flow control characteristics. Lubrica-

UNITIZED WEIGHING

for conveyor systems

Only WEIGHING COMPONENTS offers a packaged unit that:

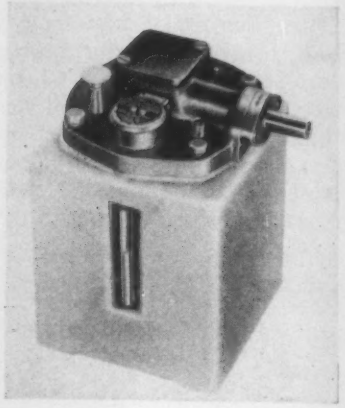
1. Fits your present or proposed conveyor system with little if any modification.
2. Responds only to vertical weight—not affected by side thrust, load placement or pile-up.
3. Measures rate and/or totalizes.
4. Offers high sensitivity with rugged simplicity.
5. Has automatic tare weight adjustment.
6. Electrical or pneumatic operation—your choice.
7. Use for indicating, recording and/or controlling . . .
8. Highest accuracy — no knife edges, levers or springs.
9. Lifetime construction.
10. Safe for all locations.

Full information available. Send for Bulletin 11.

W-C

WEIGHING & CONTROL COMPONENTS, Inc.
64-C Fulmor Ave., Hatboro, Pa.

Circle 595 on Inquiry Card



tion equipment has been successfully installed on different types of machinery operating under temperatures ranging from 200 to 500F, such as hot cut flare machines for the glass industry, flatwork ironers in commercial laundries, and valve stems of large industrial gas engines. New systems are also applicable to many machines in the food processing, chemical processing, baking and related industries. Systems are made up of three basic components: (1) Combination pump-reservoir that feeds oil at a predetermined frequency and volume into (2) a single-line distribution system, with junctions and branch lines leading to each lubricating point where (3) a meter unit filters and measures the oil and maintains one-direction oil flow. Sintered bronze filter material that can withstand high temperatures while providing effective filtering action is used in the system. Illustration shows a Type P automatic lubricator, similar to the one installed on the hot flare cut machine. Lubricator feeds measured quantities of oil through a distribution system to lubricating points on a predetermined cycle. High-temperature meter units measure and filter the oil at each point on the machine being serviced. **"Service", Bijur Lubricating Corp.,** 151 W. Passaic St., Rochelle Park, N. J.

Circle 453 on Inquiry Card

Chuck Workhead

Well suited for all cylindrical grinding, lathes and milling machines, automatic chuck workhead is self-compensating with each jaw operating independently of each other. It automatically centers

An Engineer Speaks Out...

. . . about Design Breadboards

Flexibility is one of the most important qualities in a design breadboard.

Over 250 standard components and parts make each new, improved Servoboard® electro-mechanical assembly kit one of the most flexible breadboards you can purchase.

It is easy to test a multitude of original designs with the wide variety of Servoboard components. Among the standard, precision parts are 14 pre-bored hangers which accept over 150 standard electronic servo components . . . a complete line of spur and pinion gears available in either solid set screw or split hub . . . and such brand new components as: magnetic clutches — differentials — shaft adapters — limit stops — adapter gears — anti-backlash gears—terminal assemblies—dial assemblies and calibrated inertia load discs.

Servoboard electro-mechanical assembly kits are being widely used for the design and test of guidance and control systems; high accuracy analog computer sub-assemblies; instrumentation; servo-mechanisms; motor drives; gear trains; timers; and regulators.

The economical Servoboard kits come in three models to meet every design and test need from the basic essentials to the most complex applications. Parts and components can be purchased separately.

For the full story on the new Servoboard kits and components, please fill in your name and title in the section below. Attach it to your company letterhead and mail it to me. You will receive a 16-page, fully illustrated brochure by return mail.

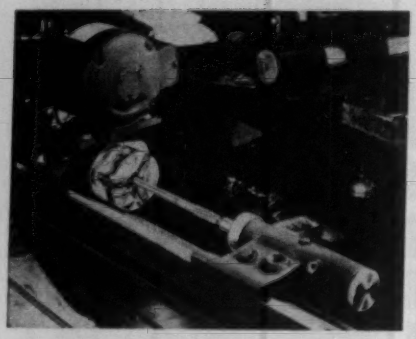
Lloyd Knight
Manager of Engineering Services

Electro-mechanical Control Systems and Components for Industry by

SERVO CORPORATION OF AMERICA

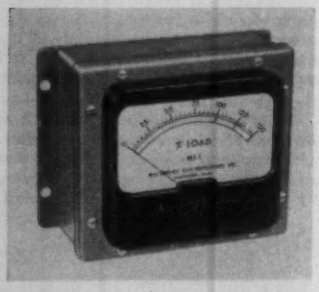
Lloyd Knight, Dept. K-18
Servo Corporation of America
20-20 Jericho Tpke., New Hyde Park, L.I., N.Y.
Please send me more information on Servoboard.
Name.....
Title.....

Circle 596 on Inquiry Card



and compensates for rough work that has centers off the OD center line 3/8-inch. The workhead grips the workpiece and drives it between two dead centers for 100 per cent concentricity. The device revolves around a dead center, cone cup, or any other kind of locating nest, on roller bearings having long, trouble free operation. The dead center is easily removed for regrinding and the jaws do not need to be adjusted or reground for runout. Called the Dead Eye Cen-Ter-All, the workhead has a range from 3/32 to 27/32-inch with only one set of interchangeable jaws. Automatic operation permits an operator to run two machines at the same time. Chuck is hydraulically or pneumatically operated; its jaws are held in position by only one screw for a fast changeover. **Modern Devices,** Box 429-A, Libertyville, Ill.

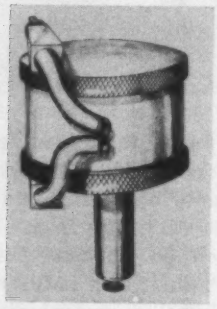
Circle 454 on Inquiry Card



Motor Load Indicator

Operator can obtain better tolerances and finishes, obtain maximum tool life and reduce tool breakage and damaging overloads with motor load indicator. Scales calibrated in either per cent load or horsepower with large color bands enable operator to see quickly how the machine is performing. The highly damped instrument reduces needle waver from mechanical vibration or minor erratic load changes. Conversion unit may be mounted near the motor starter and light control wires can be connected to the indicator. Dual voltage units are adjustable for operation on either 220 or 440v systems. **Machinery Electrification Inc.,** Dept. SRR, Northboro, Mass.

Circle 455 on Inquiry Card



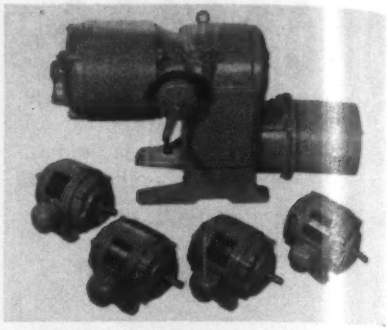
Displacement Valve

New method of accurately measuring and controlling flow of liquid or gases is provided by positive displacement valve. The unit combines all the advantages of a standard four-way valve, yet affords absolute premeasured accuracy and flow control. The controlled flow is ideal for automatic dispensing. Incorporating the precise and accurate measuring advantage of a cylinder and piston arrangement with the flow controlled by a hydraulic brake, the valve offers a wide combination of measuring or dispensing facilities in any predetermined volume. It permits measurement and dispensing from two sources to one common discharge, from two sources to two discharges, or from one source to one discharge. **Punxatawney Co.,** Punxatawney, Pa.

Circle 456 on Inquiry Card

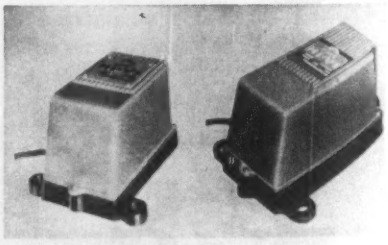
Multiple Drive System

Designed for industries where groups of variable speed motors must operate synchronously, system of synchronized variable speed, multiple drives is called the Varidyne. Most common Varidyne application is a single conveyor with two or more motors changing speeds simultaneously. Two machines or two conveyors with proportional speeds may also be coordinated by the power unit. This



type of system is of importance in applications where component parts conveyors must be co-ordinated to converge for assembly purposes. Another method of application is where the Varidyne power unit drives the primary machine, while at the same time synchronizes the speed of a secondary machine or operation by the use of a Varidyne motor. Heart of the system is a power unit which interlocks Varidyne motors by means of electrical impulses. Turning the control dial on the power unit varies the speed of every motor in the system equally and simultaneously. Motors are of the ac, squirrel-cage induction type, connected to the power unit by means of standard three-phase circuitry. Speeds from 1 to 10,000 rpm are available in ratios of up to 5 to 1 and higher speed ratios can be supplied. Motors can be furnished from 1/3 to 25 hp at maximum rpm. Valuable characteristic of the system is that when the motors are operating in tandem, as on a single conveyor, they will equally share the load. **U. S. Electrical Motors Inc.,** Box 2058, Terminal Annex, Los Angeles 54, Calif.

Circle 457 on Inquiry Card

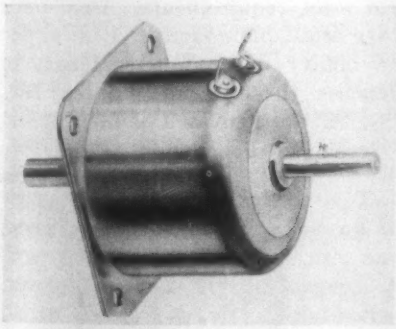


Magnetic Vibrators

Combination of a powerful permanent magnetic unit with an electromagnet operating on ordinary ac current comprises a new

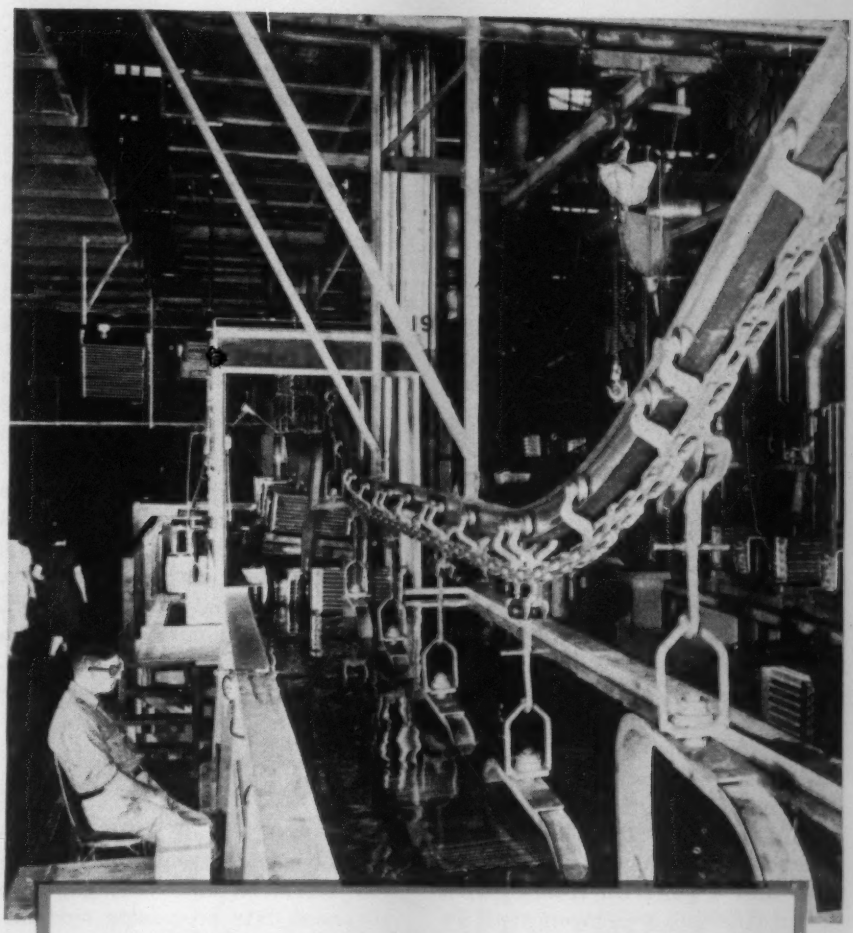
type of unit vibrator which operates at 3600 vibrations per minute. Units need no rectifiers. They transmit a rhythmic action to bins, hoppers or chutes handling dry materials in lump or powdered form, assuring a free and even flow at all times. The unit sets up a rapid double-diaphragming or kneading action in the bin wall, expanding the lower half of the bin while compressing the upper half. This action prevents sticking, arching or bridging of materials while actually imparting a pulsating directional thrust which promotes and maintains a continuous, even supply of material through the bin outlet. Vibrator is characterized by high vibration output, high efficiency, quiet operation and compact size. The combination of an electromagnet and an Alnico V. permanent magnet utilizes the principle of magnetic attraction and repulsion between magnetic poles, which are constant in the permanent magnet and alternating in the electro, thus setting up a rapid and powerful oscillation of the armature, powered on both strokes, to which is added the driving force of the energy stored in the springing system. Two models of the vibrators are available: Model EU-20, designed for bins of 7 cu ft capacity and up to 1/16-inch thickness of bin wall; and Model EU-30, designed for bins of 20 cu ft capacity and up to 3/16-inch thickness of wall. **Eriez Mfg. Co.**, Erie 6, Pa.

Circle 458 on Inquiry Card



Torque Solenoid

Designed for use in aircraft, guided missile, automation, communications equipment and other industrial applications requiring extreme reliability and long life,



How to test for leaks at 5 feet per minute

Compressors and coils must prove they're leakproof before they're charged with refrigerant. This automatic, conveyorized water test—one of many operations on the assembly conveyor—is the answer we worked out for one manufacturer.

Units are charged with air at 200 pounds pressure. Then the conveyor lowers them into a tank of clear water, and carries them past an inspector at a window in the side of the tank. When he sees bubbles, he marks that unit for repair.

We at Mechanical Handling Systems regard this as of utmost importance: Inspection and quality controls should be simple, as automatic as possible and integrated with the production flow.

The MHS engineer can contribute materials handling and automation simplifications for your production problems, too. Call him in.

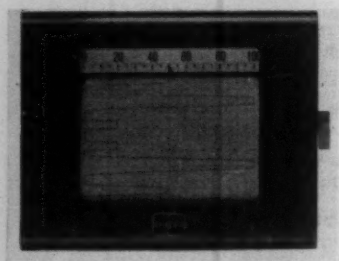
MHS

Mechanical Handling Systems Inc.
AND SUBSIDIARIES
4632 Nancy Ave., Detroit 12, Michigan
Offices in Principal Cities
FACTORIES: Detroit, Mich. • Fairfield, Iowa • Albany, N. Y. • Windsor, Ontario

Circle 597 on Inquiry Card

snap action torque solenoid features design flexibility. Axial shaft movement is eliminated, so there is no need to absorb linear shaft motion. Units can be coupled direct to the load, without the intervention of splines or complicated linkages. Any degree of shaft travel is supplied, from 5 to 60 degrees, clockwise or counterclockwise rotation, in increments as small as 1 degree. Torque values are as high as 15 lb-inch or more, depending on stroke length and duty cycle. Unit is used as a prime mover for release mechanisms, valve actuation and other applications requiring a high torque, snap action force. It can, in addition, be coupled by clutch or overriding ratchets to the driven load, to provide incremental advancement through 360 degrees. Such applications include stepping switches, circuit selectors, rotary relays, etc. These may be light duty electronic switches or heavy duty switches designed for maximum current carrying capacity. In operation, the solenoid converts axial magnetic pull into a powerful rotary stroke by means of a compensated cylindrical cam and dual rollers. Except for the shaft, all parts are completely enclosed, including the return spring. Units are adaptable to most dc voltages, in both intermittent and continuous duty models. **Pacific Solenoids Inc.**, 208 Standard St., El Segundo, Calif.

Circle 459 on Inquiry Card



Potentiometers

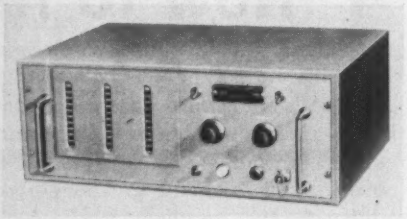
Used with analog to digital conversion devices, high-speed, self-balancing recording potentiometers are designed to give full scale traverse in 0.4 seconds. Electronic Dynamasters can be equipped with most of the standard digital readout devices. Ample torque is available for operating retransmitting slide wires, alarm contacts, and other auxiliary devices, without affecting the dynamic characteristics.

Round chart models are also available for such service, for use where prominent indication of the variables is needed while feeding digitized information to data handling equipment. Various pen speeds can be supplied, depending on the speed requirements and type of converter used. Accuracy and reliability of the potentiometer and bridge instruments are unchanged when being used with the converters. Any measurement which can be converted to an electrical value can be read out in this way, including temperature, pressure, flow, differential pressure, pH, speed, power, smoke density, etc. **Bristol Co.**, Waterbury 20, Conn.

Circle 460 on Inquiry Card

Digital Computer

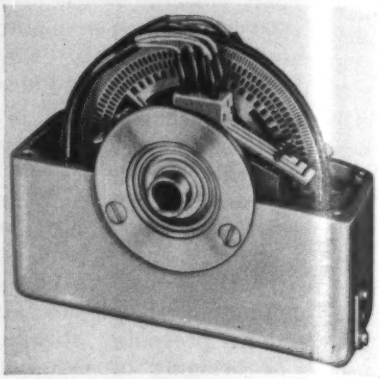
Designed for use with the frequency signals from Byron Jackson Vibrotron electronic gages in advanced data processing systems,



new digital computer is known as Model 309. Computer indicates pressure, temperature and flow directly in numbers from the frequency signals of the sensing Vibrotron gages. It gives a visual readout from 000 to 999 in steps of one, thus providing a percentage type indication for maximum utilization of digits.

Computer may be used in conjunction with a printer or electric typewriter to produce permanent digital recording of the processed data. Digital output signals from the computer can be made available in either binary or decimal form. **Byron Jackson Electronic Div., Borg-Warner Corp.**, P. O. Box 2017A, Terminal Annex, Los Angeles 54, Calif.

Circle 461 on Inquiry Card

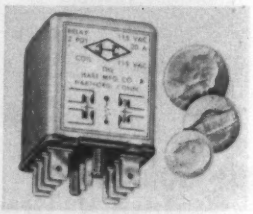


Shaft Position Encoder

Designed specifically for use in high speed servosystems, low inertia shaft position encoder is used for analog to digital conversion. The encoders provide an angular resolution of 0.3 degrees or better and can be mounted directly on the servoshaft. Thus, the unit operates at relatively low speeds, and provides long life with reliable operation. Since no gearing is required, a relatively low inertia load is reflected into the driving system; inertia effects are reduced, permitting higher servo operating speeds.

Encoder is equipped with contacts of a precious metal alloy that is able to withstand high rotational speeds. Auxiliary readout and translation units are available for use with the new Model C-100B encoder to enable readout at speeds up to 300 rpm or 300,000 quanta per minute. Unit is available with Giannini Datex binary decimal code, Gray code, or coding to meet requirements. Dual units are available coded in 1, 2, 4, and 8 binary decimal, pure binary or excess three codes. **Datex Div., G. M. Giannini & Co. Inc.**, 918 E. Green St., Pasadena 1, Calif.

Circle 462 on Inquiry Card

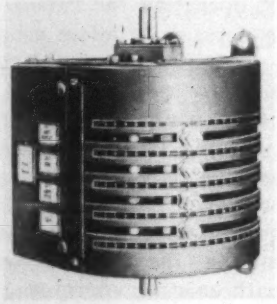


Miniature Relay

Ideal for widespread applications in automation systems as well as

in appliances, series of general purpose, heavy duty relays features small size in relation to their high capacity. Designated as Diamond H Series W, the relays measure only 1½ by 1½ by 1⅞-inches, but carry resistive loads up to 25 amp at 115 to 220v ac. Their uses include motor starting, solenoid valve control, heater circuit control, etc. Coils are available for any standard ac or dc voltages. **Hart Mfg. Co.,** 110 Bartholomew Ave., Hartford, Conn.

Circle 463 on Inquiry Card



Limit Switches

Designed for mechanical presses, rotary cam limit switches feature fast external adjustment of the cams while the press is in operation. It is unnecessary to stop the press while adjusting the timing of either the press controls or auxiliary equipment synchronized to the press cycle, eliminating much of the guesswork in the timing of the switch. Adjustment can easily be made while observing the operation of the equipment.

Spit-second timing of the control circuits is made through an adjustment of each cam by setting a thumbscrew on the outside of the housing. This adjustment is performed in safety without exposing the operator to electrical connections or moving parts. Two sizes are available, holding up to four cams in the smaller size, and up to 12 cams in the larger. A drive failure circuit stops operation of the main equipment should mechanical failure of the switch drive occur, preventing damage to the press auxiliary equipment synchronized to the switch circuits. **Danly Machine Specialties Inc.,** 2100 S. Laramie Ave., Chicago 50, Ill.

Circle 464 on Inquiry Card

for AUTOMATED Tape Controlled SPACING!

Press a button and the work is moved to an exact position under the drill.

The operator drills the hole, again presses a button and the work is moved to the next position.

It's all in the punched tape, prepared from drawings, dimensioned in two directions from a Zero corner. (x and y coordinates.)

The "reader" interprets the punched holes and both tables are moved simultaneously.

Accuracy of positioning is .001", load capacity 1,000 pounds, shipping weight 8,000 pounds.

No jigs to make, no stops to set, unlimited hole positions and the tape is stored ready for re-runs.

ARTER GRINDING MACHINE COMPANY
WORCESTER 5, MASSACHUSETTS
Jigmatic Automatic Tape Controlled Positioning Table • Rotary Surface Grinders
Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders
AGENTS IN INDUSTRIAL CENTERS OF UNITED STATES AND CANADA

Circle 598 on Inquiry Card

no need to over-tax your production facilities

Complex assemblies such as this Y-4 bombsight used in B-47 Stratojets are taken in stride at General Mills. This precision instrument has 3,433 parts, nearly 2,000 of them in this head-end assembly alone.

get precision production help in volume and on time

The critical shortage of competent technical men needn't handicap your operation. Right now our creative engineers and precision manufacturing facilities are at your service for subassemblies or complete units of:

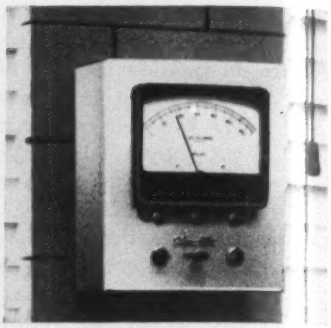
- **precision electro-mechanical systems**
- **fine-pitch, instrument-type gear assemblies**
- **precision metal cutting, grinding, finishing**
- **industrial or military optical assemblies**

We can save you time, cut costs, eliminate scores of irksome production problems. Naturally you have the service of our full laboratory and environmental testing facilities.

Send for this Fact-Packed New Booklet — It describes and pictures our facilities, shows our products, names our customers. Write Mechanical Division, Dept. AU9, 1620 Central Ave., Minneapolis 13, Minn.

***MECHANICAL DIVISION OF* General Mills**

Circle 599 on Inquiry Card



Positioning Control

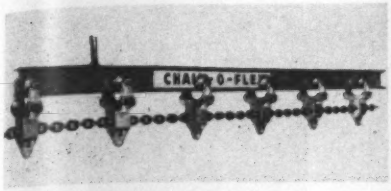
Used to remotely control position of operators for valves, gates and loaders, or to affect change in such quantities as speed, power, phase shift, power factor, pressure, flow, water level, pH factor, etc., variable remote control system enables both positioning and proportioning plus monitoring of remote equipment over one circuit. System may be used in conjunction with existing operators or can be supplied complete with reversing motors and pilot operators up to several horsepower. It is also available with transducers for telemetering such functions as pressure flow, water level, pH factor, power, speed, phase shift, position or any electrical quantity.

Bidirectional positioning is effected by polarized dc signals transmitted from a supervisory control panel (illustrated) to a remote slave receiver. Quantitative data on the controlled function is transmitted from the slave unit back to a meter on the supervisory panel. By moving a panel key, a supervisor can actuate a remote operator in either increase or decrease direction, and simultaneously observe a change in the affected function. When the desired quantity is reached, the lever key is released and the change stops. Control system features package building block module construction which can be easily installed and modified. **Sparton Control Systems Div., Sparks-Withington Co.**, Jackson, Mich.

Circle 465 on Inquiry Card

Trolley Conveyor

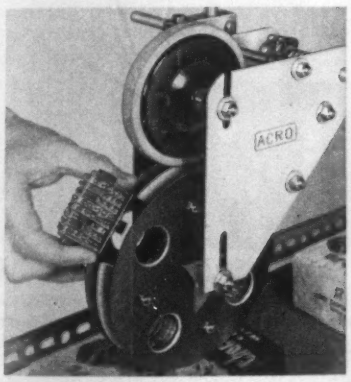
Used for conveyor jobs under all types of conditions in ovens, spray booths and for dips, T-100 Series



trolley conveyor features a specially designed chain for long life, with strength comparable to forged chains, and with an ultimate strength of 18,000 lb. Two-piece, positive grip design trolley eliminates need for load pendants. Trolley spacing is 8, 12, 16, or 24-inch centers. Trolley capacities range from 80 to 160 lb and can be doubled by the use of load bars.

Unit is designed for operation on either 3-inch I-beam or ½ by 2¼ by 2½-inch T-beam. Vertical curves of track can be furnished to requirements, ranging from 3½-ft radius up. Horizontal turns are made around traction wheels of either 23 or 30⅝-inch pitch diameters, and are available in 45, 90 and 180-degree turns. **Chain-O-Flex Corp.**, 3334 Lincoln Ave., Franklin Park, Ill.

Circle 466 on Inquiry Card



Code-Dater

Well suited for all coding, dating, price marking and imprinting operations on cartons, cans, bottles, boxes, bags, jars, cases, etc., Model 6000 code-dater contains a feature known as Liftype. The Liftype unit consists of type numerals and letters permanently mounted on rotating type bands, which are combined into a compact, removable unit that can be instantly snapped in and out.

Code-dater can be equipped with an automatic synchronizer which spots each imprint in exactly the

for your finest equipment

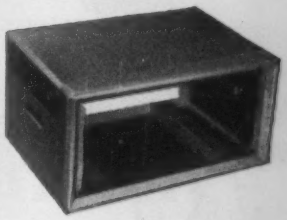
BUD "PRESTIGE" CABINETS

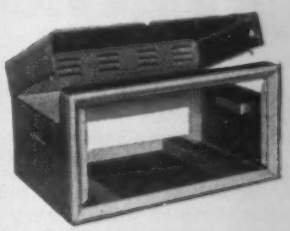
★ If you're proud of your equipment you will want to house it in the new Bud "PRESTIGE" cabinets. These new cabinets are soundly engineered and versatile in usage. They are highly stylized with eye-pleasing contours.

Note how the hinged cover—available solid or perforated — swings back completely to provide easy access. See the two movable supporting channels, adjustable laterally, adaptable to any width chassis or mounting platform.

Bud "PRESTIGE" cabinets are built of 16 gauge steel, and flawlessly finished in grey hammertone. They will accommodate standard size relay rack panels.

Despite their custom appearance they are a stock item, reasonably priced and available for immediate delivery. See them at your Bud Distributor or write us for further details.





BUD — THE MARK OF PERFECTION

BUD RADIO, INC.
2118 East 55th Street Cleveland 3, Ohio
Dept. A

Circle 600 on Inquiry Card

AUTOWEIGHTION for quality control . . .

Overweight and/or underweight packages are automatically rejected by the THAYER CHECKWEIGHER. Desired weight and tolerances are set by a dial. Remote weight indication is provided. Proof of delivery weight is printed for up to 20 packages per minute. Guaranteed shock-proof *Thayer-Plate* leverage system (no knife-edge-pivots) accurate for years and millions of weighings under dusty conditions. For engineering information please write THAYER SCALE AND ENGINEERING CORP., ROCKLAND, MASS.

Thayer
CHECKWEIGHING, FILLING & BATCHING SCALES
AMMONIUM NITRATE
DELIVERS ACCURATE WEIGHT- NO OPERATOR REQUIRED
REJECTS OFF- WEIGHTS TO YOUR TOLERANCES

Circle 601 on Inquiry Card

Fit like a Cartridge in Close Quarters

O-M (150 PSI AIR— UP TO 1500 PSI OIL)

TIE-RODLESS CYLINDERS

These compact, streamlined cylinders, that require ⅓ less installation space than the conventional type, slip easily into the hard-to-reach places, because the O-M Special Interlocking Mechanism eliminates both tie-rods and projecting end caps. Besides, the precision honed, seamless steel cylinder body can be turned down to fit in unusually tight spots.

Other important features that reduce maintenance costs and step up efficiency include:

- ***Two Point Bearing,*** one on piston and one in rod gland provide better balance and protect against drag on rod—giving O-M the lowest co-efficient of friction at low or high speeds;
- ***End Covers*** (heads) machined steel;
- ***Leather Back-ups*** on Hydraulic cylinders prevent extrusion on end plugs—O-ring seals;
- ***Piston Packings***—Self-adjusting U-cup, Vee, or ring type;
- ***Rod Packings***—self-adjusting U-cups for air, Vee-type for oil;
- ***Rod Scraper***—cleans piston and protects rod, packing and bearing;
- ***Mounts***—interchangeable, ductile iron or steel—easily installed without disassembling cylinder;
- ***Ports*** can be oriented to facilitate piping;
- ***All Cylinders*** tested at operating pressures before shipment;
- ***Cylinder*** easily disassembled, inspected, serviced, and re-assembled.

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1, or oversize rods with male or female rod end, and length of stroke to meet your requirements. Completely interchangeable parts.

Write TODAY for FREE catalog showing cylinders and complete line of mounting brackets.

ORTMAN-MILLER MACHINE COMPANY

25 143rd Street, Hammond, Indiana

☐ Have representative call

☐ Send Bulletin 103

Name_____ Position_____

Company_____

Address_____

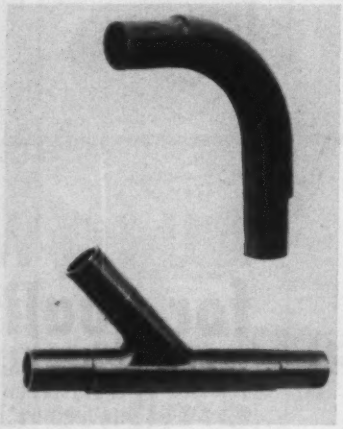
City_____ Zone____ State_____

Circle 602 on Inquiry Card

same position on each package. It is designed for easy attachment to all types of conveyors. Information such as flavors, date, weight and other data can be marked separately, or in conjunction with the code to insure positive quality control. Code-dater gives sharp, durable markings on cardboard, chipboard, cellophane, kraft paper, tape, aluminum, tin, steel, glass, wood, plastics, and on varnished, lacquered, waxed and wet surfaces. It prints on tops, bottoms and sides of any shape container.

Liftype can be supplied with four, five, six, seven or eight type bands. Each band has 13 letters and a blank space, or ten numerals and blank spaces. A choice of five type sizes, ranging from 3/32 to ½-inch in height is available. **Acro Tool & Die Works,** 4554 N. Broadway, Chicago 40, Ill.

Circle 467 on Inquiry Card



Pipe Fittings

Designed primarily for systems where materials are conveyed hydraulically, one-piece pipe fittings can also be used for pneumatic systems. For the latter, the fittings have long wearing qualities with fine materials such as boiler fly ash.

Line includes elbows with turn angles of 22½, 45 and 90 degrees to suit the piping layout. Also in the line is an integral lateral fitting with a 45-degree angle connection for the juncture of two pipe lines. Fitting sizes range from 4 to 12 inches in 2-inch increments.

To increase fitting life, wall thickness is increased on the out-

New PRESET COUNTER by FREED

MODEL 2020

The Freed Model 2020 Preset Counter is designed for low cost reliable counting applications, where accuracy and maintenance-free operation is required.

Cold cathode counting and trigger tubes, with simplified circuits, are used throughout which assure years of trouble-free counting service and low-power consumption.

Model 2020 is a 4-digit single preset counter capable of controlling any operation that is repeated up to 9,999 times. Any number from 1 to 9,999 may be preset on the 4-digit selector switches. When the preset total has been reached, the counter will provide an output pulse and close contacts on a relay. These outputs may be used simultaneously or separately to stop machines, actuate control signals, or trigger additional equipment.

SPECIFICATIONS

Maximum Count: Four digits — 9,999	**Pulse output** 50 volts
Maximum counting rate: 300,000 counts per minute	**Size:** 8 x 6 x 12 inches
Input Sensitivity and Waveform: Not critical	**Weight:** 11 pounds
Outputs: Relay contact 10 Amperes	**Power:** 25 watts 105-125 volts, 50-60 cycles
	Price: $425.00

Freed also manufactures Totalizing, Preset, and Batching Counters

SEND FOR COMPLETE INFORMATION

Engineering assistance available for adapting these counters to your specific applications.

FREED TRANSFORMER CO., INC.

1705 Weirfield Street

Brooklyn (Ridgewood) 27, N. Y.

Circle 603 on Inquiry Card

SIMPLYTROL AUTOMATIC PYROMETERS

For Control of Temperature

10 standard ranges from −200° to +3000° F.

Accuracy 2% (limit of calibration error).

Sensitivity 4 ohms per millivolt.

Cat. No. 4535, size 10" x 6" x 7". Range 0/1000°F, 0/500°C. $133.00

Thermocouple-type automatic pyrometer for controlling temperature in furnaces or ovens and manufacturing processes. Leads between Simplytrol and its thermocouple sensing element may be up to 100 feet or more depending on temperature range and lead wire resistance. Load relay, 5 amperes S.P.D.T. Optional heavy duty relays to 40 A. Either AUTOMATIC control or LIMIT shutoff. An automatic Simplytrol turns heat on and off to hold required temperature. Proportioning effect can be increased or decreased by changing cam on the sensing cycle. With shorter cycles, control more nearly approaches straight line. A limit Simplytrol locks up when the trip point is reached and remains locked until reset. Use limit Simplytrols for monitoring and safety shutoff or alarm.

Cabinet model for wall mounting or portable shown above. To the right is an MFP Simplytrol for flush mounting in a cabinet or control panel. Several other mountings are shown in Catalog 4-A. Send for your copy. **Assembly Products, Inc., Chesterland 27, Ohio.** Phone (Cleveland, O.) HAmilton 3-4436. (West Coast: Desert Hot Springs 27, Calif. Phone 4-3133 or 4-2453).

Cat. No. 4532-MFP, size 5" x 5½" x 8" deep. Range 0/1500°F. 0/800°C. $127.00

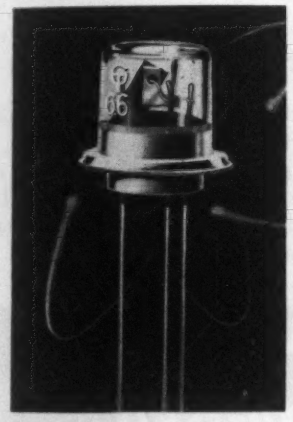
Booth 1614, Instrument-Automation Show, Sept. 17-21, N.Y. Coliseum

Circle 604 on Inquiry Card

er radius of the fitting where most of the wear occurs. The fitting design includes a longer center to face dimension on the discharge end, which removes the coupling connection as far as possible from eddies created by the bend, reducing wear at the joint.

Fittings are usually supplied with plain ends for connection by sleeve coupling to the company's Ashcolite piping which has plain ends. This method of coupling reduces installation time and permits rotation of fittings without alignment of bolt holes. Adaptors are available to permit connection of the fittings to flange assemblies, such as flange pipe or machinery. **Allen-Sherman-Hoff Co.**, 259 E. Lancaster Ave., Wynnewood, Pa.

Circle 468 on Inquiry Card



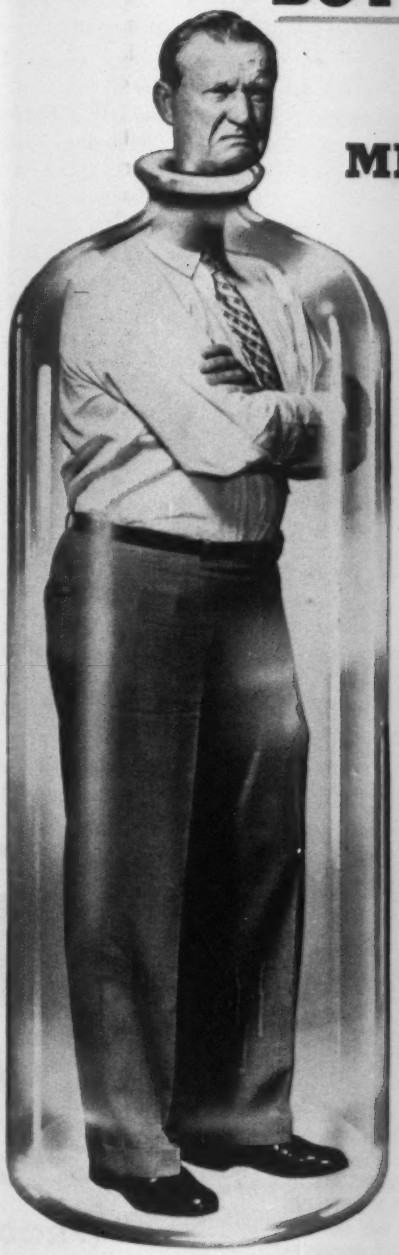
Phototransistor

Used for automobile automatic headlight dimmers, tape and punch card reading, optical sound playback, liquid level control, television receiver automatic brilliance control, industrial safety devices, automatic door openers, etc., germanium p-n-p alloyed junction three-lead phototransistor is also sensitive to relative position of the light source making it useful in positioning controls.

Known as type GT-66, the miniature, light-sensitive photocell is intended for use in circuits employing ac amplification for modulated light. It may also be used as a two-lead device with dc light. Even though it is small, phototransistor is capable of performance at a level sufficient to operate a relay. **General Transistor Corp.**, 130-11 90th Ave., Richmond Hill 18, N. Y.

Circle 469 on Inquiry Card

ELIMINATE PRODUCTION BOTTLENECKS...



AUTOMATE METAL CLEANING WITH DETREX EQUIPMENT

Are hand-operated metal cleaning operations the bottleneck in your production flow? Are you putting up with the cost and confusion of centralized cleaning operations? Detrex can quickly solve both of these profit-eating conditions by placing your metal cleaning operation in sequence right within your present production lines . . . automated or otherwise.

Whether you need alkaline or emulsion cleaners (dip or spray), solvent degreasing, or fast, hard-scrubbing ultrasonic cleaning, Detrex will provide equipment tailored to your production requirements. Added to this, Detrex also produces the cleaning chemicals for these operations and thus can guarantee performance of the entire operation.

To keep your metal cleaning processes in step with the rest of your production, why not have a talk with your nearest Detrex field technician? Use the coupon below to get the ball rolling today . . . no obligation.

☐ I am interested in automating my ____ degreasing ____ washing operation.

☐ Please send literature on standard Detrex equipment. Dept. A-619

☐ Have a field technician call on me.

NAME _____

COMPANY _____

ADDRESS _____

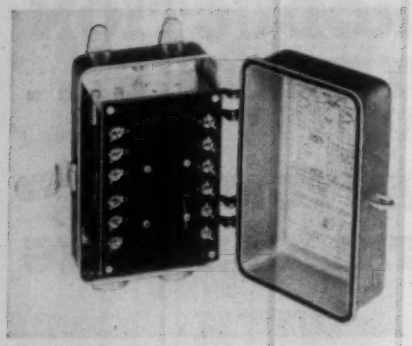
CITY _____ ZONE _____ STATE _____

DETREX CHEMICAL INDUSTRIES, INC.

BOX 501, DETROIT 32, MICHIGAN

DEGREASERS • DEGREASING SOLVENTS • WASHERS • ALKALI AND EMULSION CLEANERS • PHOSPHATE COATING PROCESSES

Circle 605 on Inquiry Card

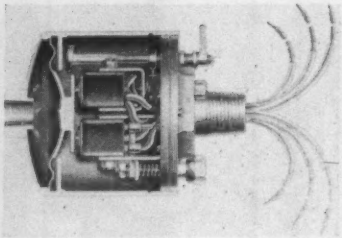


Level Control

Designed for the control of all electrically conductive liquids in the chemical, waterworks, food processing, dairy and sewage fields, electromagnetic level control is designated Type 10CB4. Used with Photoswitch probe type fittings, the control provides maintenance free operation with flexibility of application. There are no moving parts in the tank and no floats or stuffing boxes to wear or fail in operation. Four different ranges of resistivity of the probe circuit are provided to match the conductivity of the liquid being controlled. The unit can be used for single level indication or alarm, or pump-up or pump-down control.

Control operates on 115 to 230 v, 25 to 60 cycles ac. Low ac voltage is employed in the probe circuit which assures safety and eliminates the problem of electrolysis. **Photoswitch Div., Electronics Corp. of America,** 77 Broadway, Cambridge 42, Mass.

Circle 470 on Inquiry Card

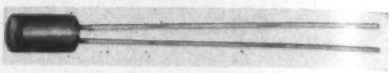


Pressure Switch

Used to signal when pressure rises or falls to danger zone and then to shut down the system if pressure continues to rise or fall to a predetermined safety limit, system combines two pressure switches in one unit. The manual reset is so arranged that the system cannot be reactivated until the pressure has been returned to a safe level.

Each switching element in the unit can be electrically independent of the other (one ac, the other dc if necessary) or two external leads can be supplied to control a single circuit between maximum and minimum pressures. Designated as Model 432, the pressure switch is available in three classes of proof pressures: 6, 30 and 120 psi, with an adjustable range from 0.05 to 100 psi. **Barksdale Valves, Pressure Switch Div.,** 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 471 on Inquiry Card



Photocells

Conveyor control, door control, counting, smoke detecting, etc., are among applications of line of cadmium sulphide photocells. Units are divided into 11 sensitivity categories. Low impedance cells are

STANDARD HEAVY DUTY SUPER PRECISION SPINDLES

"Masters of Milling"

No. 6037 MT

No. 6009 M

AMERICA'S MOST EXTENSIVE LINE OF MILLING SPINDLES!

A milling spindle for every purpose . . . and more than that . . . a milling spindle reflecting in its SUPER CAPACITY AND TROUBLE FREE OPERATION the four decades of its maker's experience in spindle manufacturing. And "special problems"?... get the answer from Standard experts!

From 1 to 200 HP with standard tapers, #20 to #60. To satisfy every milling demand — enclosed, totally enclosed fan-cooled, high cycle and liquid-cooled. Motorized or Belt-Driven. Variable, single or multiple speed motor — Speed to suit your application.

Write Today for Spindle Catalog! | Booth 1047 • Metal Show Cleveland • Oct. 8-12

SUPER PRECISION SPINDLE DIVISION

the STANDARD electrical tool co. SINCE 1912

STANDARD SETS THE PACE!

2549 RIVER ROAD • CINCINNATI 4, • OHIO

Circle 606 on Inquiry Card

NEW LONDON "Moto-Belt" CONVEYOR

- PRODUCTION
- ASSEMBLY
- PACKAGING
- INSPECTION

LOW COST

Hundreds of USES . . .
ADAPTABLE to practically ALL conditions!

BELTS: 2" to 18" wide; White Cotton or Stitched Canvas; Rubber or Neoprene; Plastic or Wire Mesh.

Variable Belt Speeds — Adjustable Stands — Side Rails — 10' sections up to 80' — Steel, Aluminum or Stainless Steel.

Investigate TODAY — Send for Catalog

NEW LONDON ENGINEERING CO.

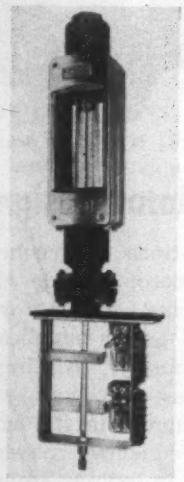
DEPT. A NEW LONDON, WISCONSIN

Circle 607 on Inquiry Card

intended primarily for direct relay operation, while high impedance cells are intended for use with an amplifier. The sensitivities range between 20 and 1500 microamperes (5 megohms down to 67,000 ohms) at the low illumination of 1 ft-c. With proper amplification, photocells will detect 0.001 ft-c.

Elements are light sensitive over the entire visible spectrum, with a peak sensitivity to a blue-green color. They have a low noise le and high dark resistance; stabili is rated excellent as long as po er dissipation is not exceeded. Miniaturized units will control a commercial sensitive relay without amplifications. **Hupp Electronics Co., Div., Hupp Corp.,** 743 Circle Ave., Forest Park, Ill.

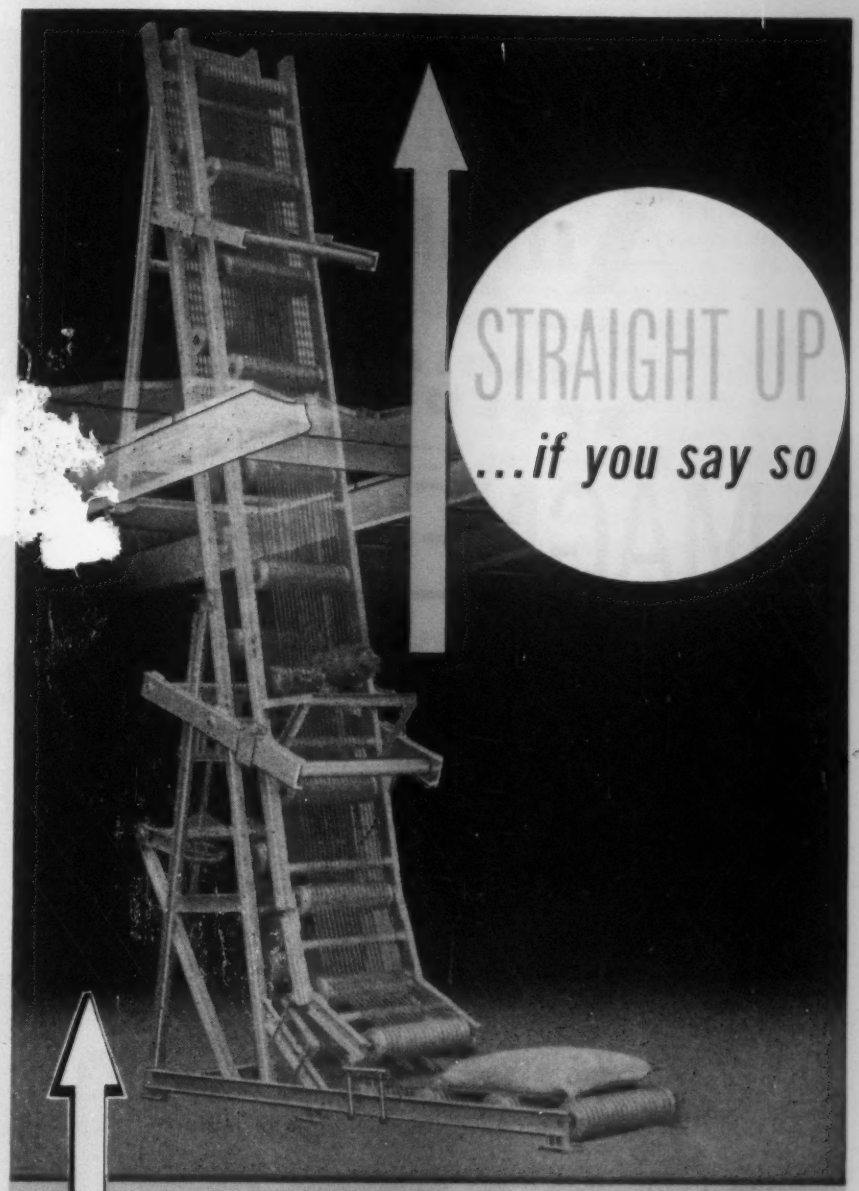
Circle 472 on Inquiry Card



Flow Alarm

One of the most important applications of the new flow alarm is in water or oil cooling lines for large machines. It may be connected to a light or buzzer or both, or may be used to start a pump, close a valve, shut down the system, or perform other on-off control functions. Although used most often for flow applications, new vibration proof switch can be used for alarms in the measurement of any variable such as liquid level, temperature or pressure capable of positioning an extension rod.

Known as the Ratolarm, the device uses two snap action electrical contacts, hermetically sealed in a



This POWER-CURVE Elevator can Lift or Lower bags or packages at any angle or height. Selective discharge is possible for any number of floors. Bag flattening action between the two powered conveying surfaces results in better stacking, easier handling.

With POWER-CURVE equipment, you can automatically move bagged material from box-car or truck direct to warehouse without re-handling or hand trucking—at any speed, up to 30 bags per minute with ease. Ask for literature—quotation to your specifications.

NEW MOVIE AVAILABLE—16mm color-sound film of various **POWER-CURVE** installations in operation. Shows you more in ten minutes than you can learn from hours of listening or reading. Movies available locally from representatives in all principal U. S. cities. Write for showing.

POWER-CURVE CONVEYOR CO.

2187 SOUTH JASON STREET • DENVER 23, COLORADO

Circle 608 on Inquiry Card

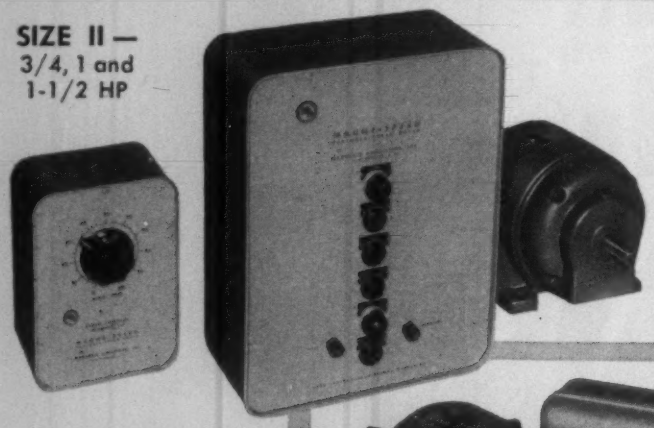
Magnetic Amplifiers · INC

VARIABLE SPEED DRIVE

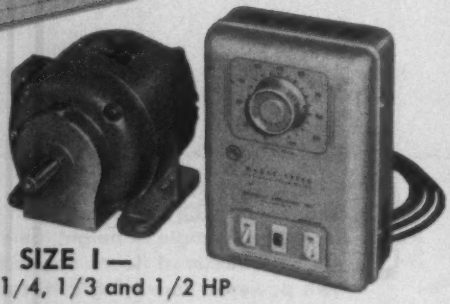
MAGNE-SPEED*

*Trade Name

SIZE II — 3/4, 1 and 1-1/2 HP



SIZE I — 1/4, 1/3 and 1/2 HP



Stepless, instant starting, compact, 50:1 speed range, good regulation without tachometer, long life, virtually maintenance free service, low cost, fast response, reversibility, dynamic brake, local or remote control. Write for Bulletin S580-5-55.

Other MA Products and Services

Magnetic Servo Amplifiers, Analog Computors
Transi-Mag* Amplifiers, Photoelectric Controls
DC and AC Regulated Power Supplies

Application engineering and conversion of tool machines and production processes to automatic control.

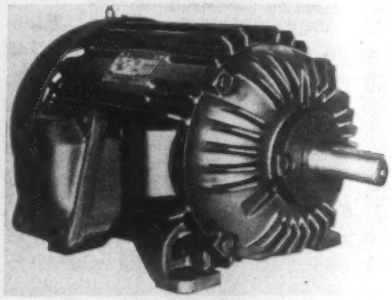
Magnetic Amplifiers • Inc
632 TINTON AVE., NEW YORK 55, N. Y.—CYpress 2-6610
West Coast Division
136 WASHINGTON ST., EL SEGUNDO, CALIF. — EAstgate 2-2056

Circle 609 on Inquiry Card

glass tube, which are drawn together to set off the alarm by passage of a magnetic float extension rod. The switch can be positioned in the mounting frame either above or below the magnet in the float extension rod to give a signal for either high or low limits of flow.

The Ratolarm will replace the mercury switch and inductance coil types formerly used on Fischer & Porter instruments for flow alarm applications. **Fischer & Porter Co.**, 553 Jacksonville Rd., Hatboro, Pa.

Circle 473 on Inquiry Card

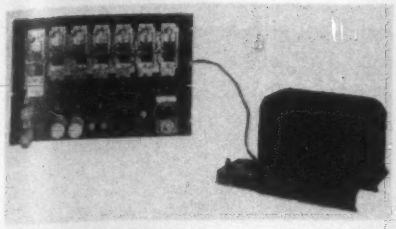


New Motor Design

Applications of synchronous induction motor include high speed meat slicing, drives for military electronic power supplies, packaging machinery, printing presses, sheet glass conveyors, wire drawing, continuous bristle cutting, and stable frequency converter sets. Available in ratings from ¼ to 40 hp, Synduction motor requires no brushes, slip rings or windings on the rotor, no separate source of direct current excitation or special starting equipment. Device starts as an induction motor with a very high locked rotor torque, accelerates and pulls into synchronism quickly, and runs as a synchronous motor. Having a high (175 to 200 per cent) pull-out torque, the motor remains in synchronism regardless of load or line voltage fluctuations.

Frequencies of 300 cycles and speed above 10,000 rpm are available. Motors need only standard across the line starting equipment, except in the largest ratings, where reduced voltage starters are required. **Allis-Chalmers Mfg. Co.**, Milwaukee 1, Wis.

Circle 474 on Inquiry Card



Signal Generator

Useful for the automatic transmission and recording of identifying information in data logging or communication systems, date and time signal generator provides a teletype line signal consisting of the day, month, year, hour, minute and a number of other preset characters on demand. Date and time signals are set up automatically on stepping switches and can be arranged for either 12 or 24-hour clock operation. Transmission of the signals is initiated at any time by closing a remote contact or operating a pushbutton on the generator panel.

Generator consists of two 19-inch relay rack panels; one, 12¼ inches high, contains the stepping switches and synchronous motor timer, while the other, 10½ inches high, forms the mounting shelf for the transmitter-distributor. **L & R Products,** 52 Lake Rd., Framingham, Mass.

Circle 475 on Inquiry Card

Portable Controller

Minimum size with wide application flexibility are features of Model 6140 portable controller. Consisting of an ultrasensitive electronic switch, the tiny unit will control up to 500 w of power, either delivered at 115v ac, 60 cps, or switched by its internal contacts. A self-contained rotary switch allows rapid panel selection of any of four output functions, whether it is power supplied normally on or normally off, or switching normally open or normally closed.

Variations in controller packaging are available, including a recessed panel mounting and function selector switch locking provision to prevent tampering. Variety of pickups are suitable for use as input sources for the controller, including the Model 6130 photoelectric detector, an ultraminiature element of high sensitivity which has found application in confined locations.

Another useful pickup element which can be used with the controller is the Model 6120 proximity detector probe. This device is capable of detecting the presence of all metallic and certain nonmetallic articles adjacent to its detection face, providing counting or liquid level detection without the use of light beams or physical contact with the part or material.

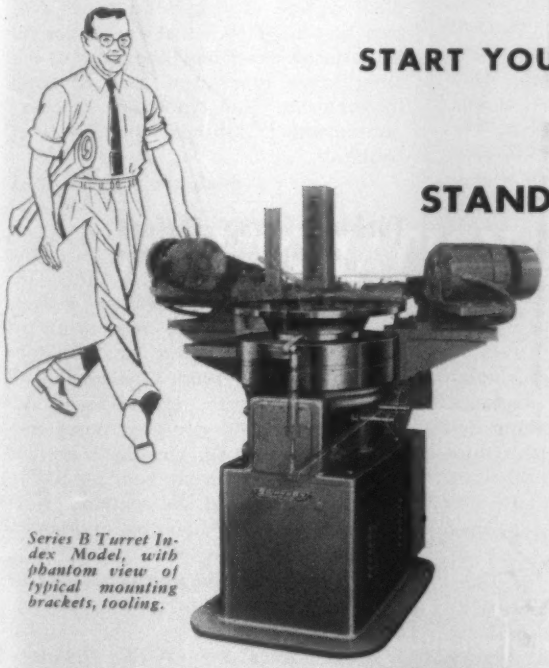
Controller also finds application where extremely low forces are available to actuate a minute contact switch, since an immeasurable current through the contacts will cause actuation of the unit. **Autron Engineering Inc.,** 1254 W. Sixth St., Los Angeles 17, Calif.

Circle 476 on Inquiry Card

START YOUR **AUTOMATION** PLANNING WITH

SWANSON

STANDARD INDEXING MACHINE CHASSIS



Series B Turret Index Model, with phantom view of typical mounting brackets, tooling.

Save valuable engineering time and cut the cost of building your automatic and special purpose machines

You can get the benefits of automation *without making a large capital expenditure.* You can easily justify automation projects by building your special machinery around a Swanson standard chassis.

These versatile "packaged" units provide the basic chassis for a wide range of special purpose automatic machines. Because they eliminate much of the engineering and building formerly required, Swanson units lower costs and shorten completion time . . . considerably broadening the applications of automation.

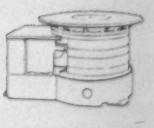
Write for Bulletin 356-A. It describes the complete line of Swanson Standard Index Machine Chassis.

SWANSON TOOL & MACHINE PRODUCTS, INC. · ERIE, PA.

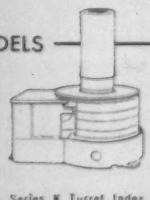
ENGINEERS AND BUILDERS OF AUTOMATIC AND SPECIAL PURPOSE MACHINES SINCE 1919

OVER 200 STANDARD MODELS

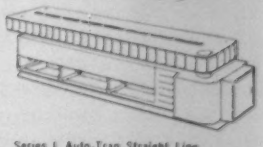
Series B & C Turret Index Models—for medium and light applications



Series H Turret Index Models—for heavy duty applications.



Series K Turret Index Models—for heavy duty applications with center column tool mounting.



Series L Auto-Trac Straight Line Indexing Chassis—for automatic or semi-automatic assembly and processing operations.

catalogs and literature

Latest automation information. For copies use card page 17.

Fire Resistant Fluid

Monsanto Chemical Co., Organic Chemicals Div., St. Louis 1, *Mo.*—20-*page booklet*—Used for hydraulic equipment operating near possible sources of ignition, Pydraul F-9 is the subject of illustrated booklet. Fire resistant fluid is used in such applications as diecasting machines, hydraulic presses, furnace tilters, plating machines, etc. Information on general properties, stability, laboratory and pump tests is included.

Circle 477 on Inquiry Card

Control Components

General Electric Co., Bloomington, Ill.—68-*page handbook*—Complete line of general purpose control devices is described and illustrated in comprehensive handbook, GEC-1260A. Specifications, pictures, operating characteristics and applications of starters, contactors, relays, solenoids, pilot devices, switches, etc. are given. Price lists, heater selection tables and coil data are included.

Circle 478 on Inquiry Card

Pneumatic Tube Systems

Grover Co., 25525 *W. Eight Mile Rd., Detroit* 19, *Mich.*—36-*page catalog*—Capable of providing a simple connection between general office and a single department or automatic communication between many offices located considerable distances from one another, line of pneumatic Transitube equipment is thoroughly described and illustrated. Cash and message carriers, automatic carrier selection system, tube bends, desk mounted equipment, recessed terminals, and spacers for automatic systems are illustrated, and their specifications are given.

Circle 479 on Inquiry Card

Pyrometer Indicators

Thermo Electric Co. Inc., Rochelle Park Post Office, Saddle Brook, N. J.—8-*page bulletin*—Used in food and chemical processes, pilot plants, heat treating, plastic molding, die casting and engine test cells, millivoltmeter type pyrometer indicators are described in bulletin No. 25-3. Available models, their specifications and dimension drawings are included.

Circle 480 on Inquiry Card

Recorders and Controllers

Minneapolis-Honeywell Regulator Co., Indusrial Div., Wayne & Windrim Aves., Philadelphia 44, *Pa.*—18-*page booklet*—Equipment for measuring, indicating, recording and controlling electrochemical variables such as pH, Redox and conductivity is described in Catalog 1551. Basic measurement and control systems, amplifiers, electrodes, conductivity cells, indicators, recorders, controllers and valves are discussed and illustrated.

Circle 481 on Inquiry Card

Coated Abrasives

*Minnesota Mining & Mfg. Co., Dept. F*6-189, 900 *Fauquier St., St. Paul* 6, *Minn.*—12-*page bulletin*—Case history presentations of prefinishing, weld grinding and blending, removing imperfections, and finishing and polishing operations are given in illustrated booklet. Among abrasive types shown are belts, sheets, disks and polishing and grinding wheels.

Circle 482 on Inquiry Card

Lightweight Conveyor

Jervis B. Webb Co., Dept. NLP, 8951 *Alpine Ave., Detroit* 4, *Mich.*—8-*page bulletin*—Ten typical industrial uses for lightweight overhead conveyor units are illustrated and described in Bulletin 954. Specifications and information on the advantages of the conveyors are included.

Circle 483 on Inquiry Card

Fluid Power Systems

Oilgear Co., 1585*D W. Pierce St., Milwaukee* 4, *Wis.*—12-*page bulletin*—Designed to simplify fluid power application and to provide precision fine feeds and high traverse speeds, line of controlled fluid power sources is the subject of Bulletin 44200-A. Flow diagrams, features, cycles, specifications, electric control systems, electrical control circuits, limit switch control panels and cam and rails of the power packages are described.

Circle 484 on Inquiry Card

Variable Speed Transmission

Revco Inc., 2 *E. Franklin Ave., Minneapolis* 4, *Minn.*—12-*page bulletin*—Used in testing, machine tool, photographic, metalworking, packaging, electrical and plastic fields, variable speed transmission is the subject of illustrated bulletin. "How-to" section, applying to all transmission equipment, covers measuring of torque, starting and running, boosting power or speed, special drives and motors. Installation data, dimensions and ratings of various models are included.

Circle 485 on Inquiry Card

Self-Aligning Couplings

Ajax Flexible Coupling Co. Inc., Westfield, N. Y.—8-*page bulletin*—Misalignment up to 3 degrees is handled by line of couplings which feature patented dihedral tooth design. Bulletin 60 describes principles of design, gives lubrication and ordering information, and includes cutaway photograph and dimensional sketch of coupling.

Circle 486 on Inquiry Card

Turbine Pump Motors

U. S. Electrical Motors Inc., Box 2058, *Los Angeles* 54, *Calif.*—16-*page booklet* — Verticlosed motors which are designed to become an integral part of a pump are the subject of Booklet 1903. Grease and oil lubricated models, single-phase designs and totally enclosed pump motors are described. Graphs illustrate the relation of thrust bearing life to contact angle, and the starting characteristics of part-winding increment start motors.

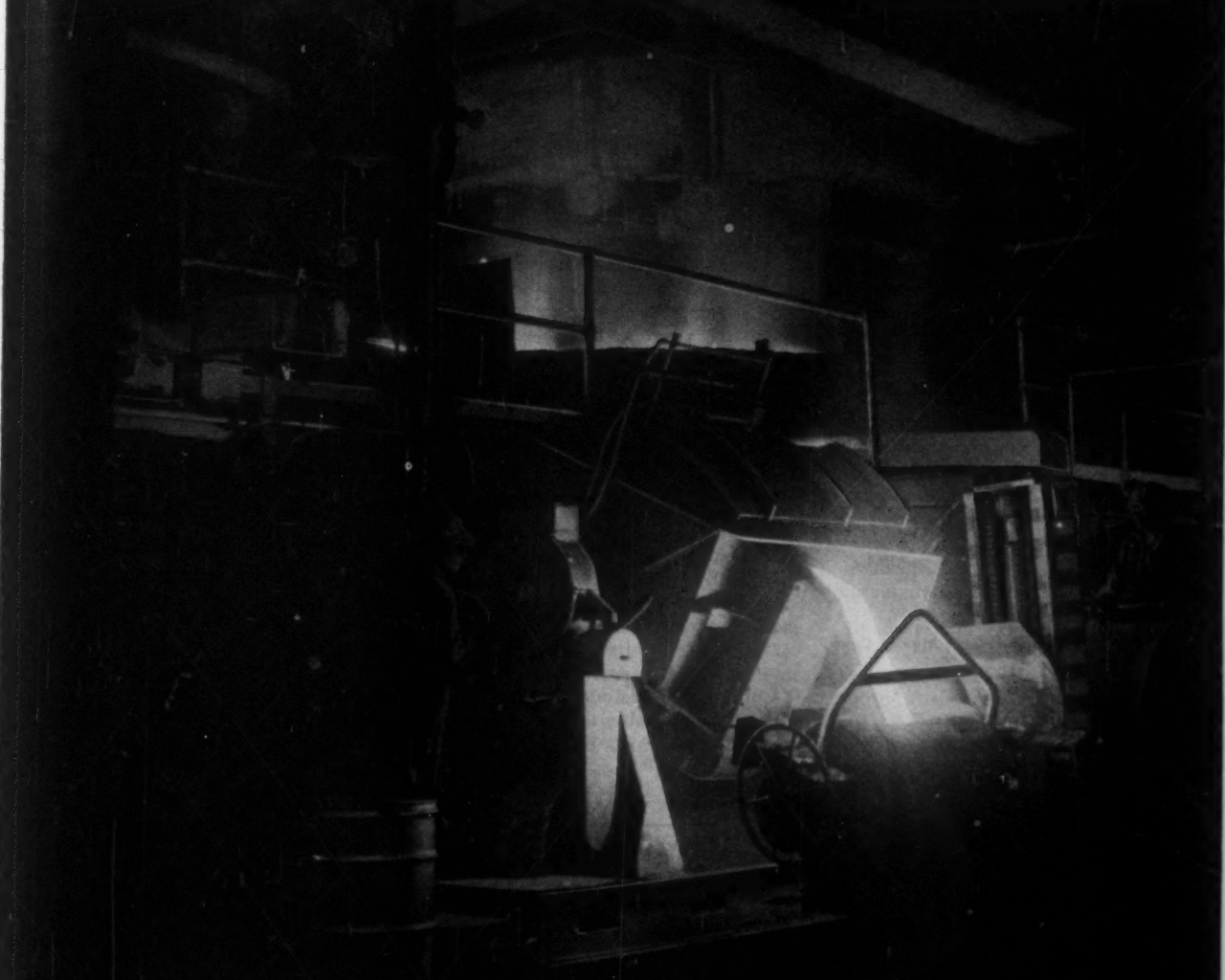
Circle 487 on Inquiry Card

Welding Control

Sciaky Bros. Inc., Public Relations Dept. L-10, 4915 *W.* 67*th St., Chicago* 38, *Ill.* — 8-*page bulletin* — Predetermined, electronic counter welder control is the subject of Bulletin No. 338. Tube type control counts cycles of power line frequency to control welder sequence. Development of welder control and features of control equipment are discussed.

Circle 488 on Inquiry Card

ENGINEERS SERVING THE FOUNDRY INDUSTRY FOR MORE THAN 30 YEARS



Is AUTOMATION the Answer for Your Foundry?

For low cost, high volume foundry production—the answer *is* Automation. Whether your interest lies in ferrous or non-ferrous castings—shell molding or CO_2 process, steel or malleable, production or jobbing—Foundry Automation can be *your* solution to rising costs, improved casting quality, and greater output.

Foundry automation at Giffel's & Vallet is a highly developed science . . . one that has established new standards of production and quality control for the foundry industry. Giffels & Vallet planning and engineering is reflected in many automated foundry installations, both at home and abroad—ranging from such companies as Ford, U. S. Steel, Lynchburg, Fiat, Unitcast—to many smaller foundries equally interested in the benefits to be had from automatic operation.

G&V services are discussed in a special Foundry Brochure. A copy will be mailed on request.

INDUSTRIAL ENGINEERING DIVISION

Giffels & Vallet inc.

DETROIT 26, MICHIGAN New York, Chicago, Houston • Toronto and Windsor, Ont.

Plant Layout • Process Development • Automation Engineering • Materials Handling • Equipment Design • Building Design

Air Gages

Federal Products Corp., 1144 *Eddy St., Providence* 1, *R. I.*—32-*page catalog*—Combination of air gaging with electronic gaging to permit automatic gaging and sorting of workpieces is one of a variety of applications of Dimensionair gages, described in Catalog 56D. Direct reading air gages feature setting with a single master and high accuracy operation, with a guaranteed linear scale. Air gage head, called the AirProbe, is also described, with its specifications and applications covered.

Circle 489 on Inquiry Card

Automatic Screw Machines

Cleveland Automatic Machine Co., Cincinnati 12, *O.*—8-*page bulletin* — Seven models of single-spindle, automatic screw machines are described and illustrated in new bulletin. Applications of different models vary from use in general line of screw machine work to heavy forming, turning and end work operations. Specifications, applications and photographs of each model are included.

Circle 490 on Inquiry Card

Hydraulic Cylinders

Galland-Henning NOPAK Div., 2734A S. 31st St., Milwaukee 46, *Wis.* —12-*page bulletin*—Designed for 200 psi service, line of hydraulic cylinders, designated as Class 4, is the subject of Catalog 104. Mounting brackets, rod clevises, and special cylinders are described. Engineering data and dimensions of the Class 4 cylinders are included.

Circle 491 on Inquiry Card

Flexible Shafting

Stow Mfg. Co., 197 *Shear St., Binghamton, N. Y.*—12-*page bulletin*— Used in power drive or remote control applications, flexible shafting is described and illustrated in Bulletin No. 570. Information on core selection, casings, reinforcements, terminals and casing ferrules is given. Typical integral design connections are pictured.

Circle 492 on Inquiry Card

Sealed Thermostats

Instrument Div., Thomas A. Edison Inc., W. Orange, N. J.—8-*page bulletin*—Used for temperature control of crystal ovens, oscillator compartments and other places affected adversely by temperature variations, sealed thermostats are the subject of illustrated bulletin. Specifications, mounts, and design data of the controllers are included. Information on contact protection and use with ac and dc loads is also given.

Circle 493 on Inquiry Card

Circuit Selectors

G. H. Leland Inc., 123 *Webster St., Dayton* 2, *O.*—12-*page bulletin*— Power operated rotary switch which is designed for remote control of predetermined circuit patterns is the subject of bulletin No. 456 CSR. Various designs of stepping, counting, adding and subtracting, latching and circuit selecting relays are made possible by combination of rotary solenoid and wafer type rotary switches. Control circuits, circuit wafer switches, and special relays are described and illustrated in the bulletin.

Circle 494 on Inquiry Card

Solving Cleaning Problems

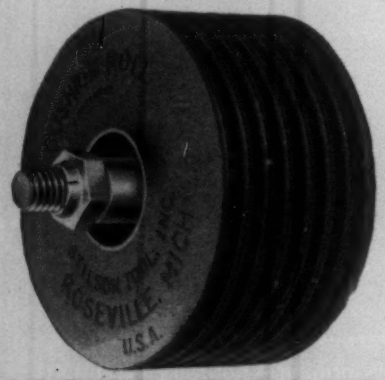
Wheelabrator Corp., Mishawaka, Ind.—36-*page catalog*—Used for the cleaning of cylinder blocks, pipe, tubing, valve springs, cylinder sleeves, transmission parts, and for shot peening, line of blast cleaning cabinets is the subject of Catalog No. 724. Actual applications in the automotive, aviation, railroad, steel, container reconditioning, weldment and ordnance fields are illustrated and briefly described.

Circle 495 on Inquiry Card

Coolant Pumps

Tuthill Pump Co., 939 *E. 95th St., Chicago* 19, *Ill.*—8-*page bulletin*— Line of rotary, internal gear, positive

NEW • • • NEW



RUBBER ROLLERS FOR CONVEYORS

- Provide Cushioned, Scratch Free Rides
- Suitable for Finished Stampings, Glass, Plexiglas
- Used for Die Lifters, Hydromatic Welders, Gravity Roll Conveyors, etc.

FIVE MODELS — THREE DENSITIES
4" Dia. — 2" wide 2½" Dia. — 2" Wide

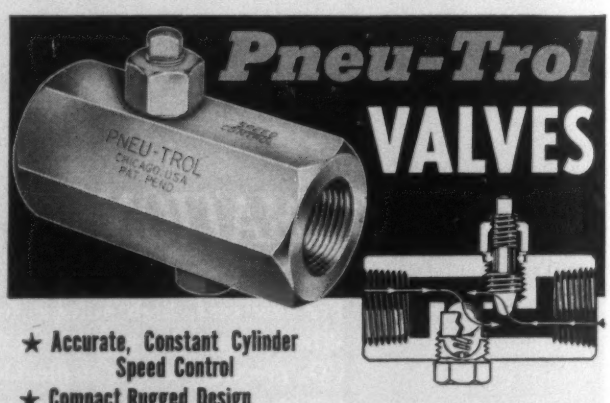
DUAL BALL BEARING ALLOY AXLE — SELF LOCKING NUT
ALL PARTS INTERCHANGEABLE

Write for further information

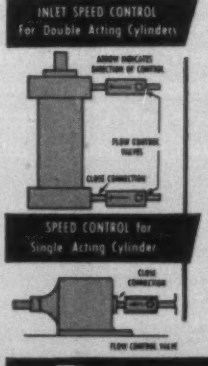
STILSON TOOL INC.
30229 GROESBECK HWY., DEPT. A.
Phone PRescott 8-2010 Roseville, Mich.

Circle 612 on Inquiry Card

Pneu-Trol VALVES



★ Accurate, Constant Cylinder Speed Control
★ Compact Rugged Design
★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications



Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

Write for illustrated circular and prices.

Pneu-Trol DEVICES, INC.
1420 N. KEATING AVENUE • CHICAGO 51, ILL.

Circle 613 on Inquiry Card

displacement pumps which feature an automatic internal relieving feature is the subject of Catalog No. 104. Self-priming pumps are used for applications requiring positive delivery, high suction lift and protection against excessive pressure. Dimensions, parts tables, illustrations and information on modifications of the Model M pump are given.

Circle 496 on Inquiry Card

Automated Speed Control

Graham Transmissions Inc., Menomonee Falls, Wis.—4-page pamphlet—Variable speed drives which provide automated control based on mechanical, electrical or pneumatic signals are described in Bulletin No. C-100. Ways in which automated speed control is used to maintain a constant velocity feeding and winding, variable proportioning, punch card product blending, etc. are described and illustrated.

Circle 497 on Inquiry Card

Control Units

Royal Design & Mfg. Inc., 4133 E. Ten Mile Rd., Centerline, Mich.—4-page pamphlet—Used in machine tool building and manufacturing plants using transfer machines, Cy-Co-Trol tool control units are the subject of illustrated pamphlet. Information on keeping machines operating at top capacity, eliminating downtime and trial runs and reducing tool breakage is included.

Circle 498 on Inquiry Card

AC Rotary Solenoids

Leetronics Div., Lee Spring Co. Inc., 30 Main St., Brooklyn 1, N. Y.—6-page pamphlet—Capable of converting electrical energy into rotational mechanical work with precise movement, ac rotary solenoid is the subject of illustrated pamhplet. Three different solenoid models are shown; application photographs of solenoids used on counter, brake and stepping switch are included.

Circle 499 on Inquiry Card

Industrial Relays

Ohmite Mfg. Co., 3637 Howard St., Skokie, Ill.—4-page pamphlet—Complete information on four relay models which are available in 65 different types is given in Catalog R-29. Photographs, specifications, mounting sketches and general description of the relays are included.

Circle 500 on Inquiry Card

Custom Control Systems

Gemco Electric Co., 25685 W. Eight Mile Rd., Detroit 19, Mich.—4-page pamphlet—Examples of electrical and electronic custom designed controls are included in pamphlet. Photographs of four-loop conveyor control, automatic nail driver control, transfer machine control, polishing machine control, boring machine control and combined electro-hydraulic control for welders are included.

Circle 501 on Inquiry Card

Proximity Transducer Systems

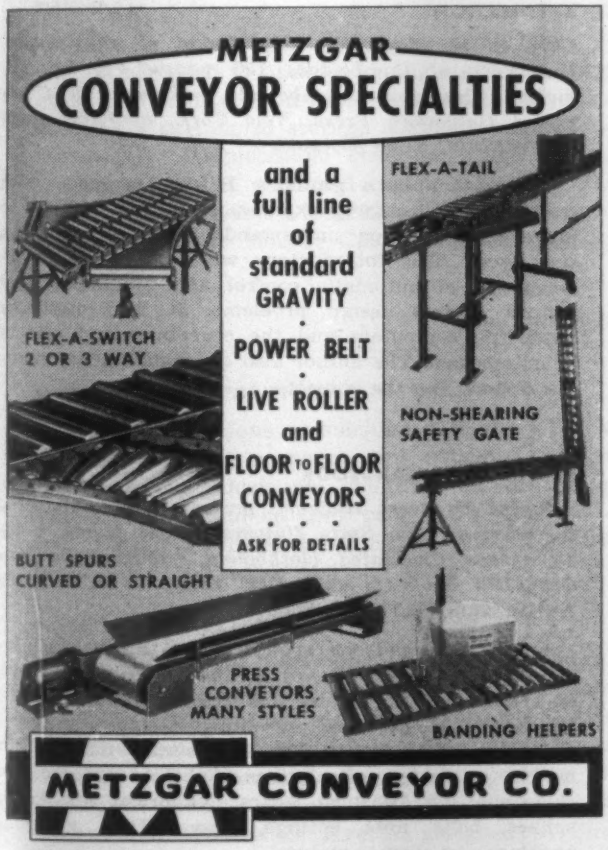
Electro Products Laboratories, 4501 N. Ravenswood Ave., Chicago 40, Ill.—4-page pamphlet—Used to actuate and control electromechanical or electronic devices automatically, proximity transducer systems are described in Bulletin CPP356. Systems consist of a proximity transducer, a shielded connecting cable and a control unit and are capable of sensing operations in excess of 1000 per second.

Circle 502 on Inquiry Card

Deburring and Chamfering

Modern Industrial Engineering Co., 14230 Birwood Ave., Detroit 38, Mich.—2-page pamphlet—Two models of automatic gear processing machines are described and illustrated in Bulletin No. 103-112. Single-station machine deburrs and chamfers entire tooth form of internal gears and splines; two-station machine deburrs and chamfers both sides of external gears.

Circle 503 on Inquiry Card



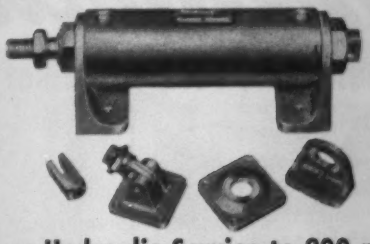
408 DOUGLAS ST., N.W., GRAND RAPIDS, 4, MICHIGAN

Circle 614 on Inquiry Card

Modernair

ECONOMAIR CYLINDERS

Tops in Quality, Economy, Compactness!



For Air or Hydraulic Service to 200 psi

- ★ Compact — feed ring head design eliminates bulky end castings!
- ★ Interchangeable mountings — flange, clevis, L-type
- ★ "O" ring seals throughout
- ★ Available in 1¼", 2" and 3" bore sizes, any practical stroke length, cushion or non cushion types

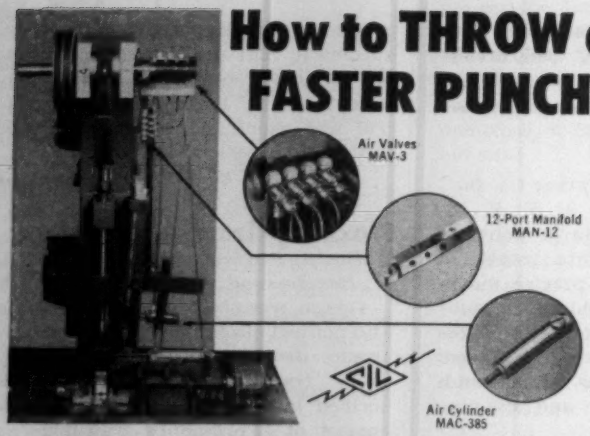
Economair series cylinders offer today's best buy in quality cylinders at truly competitive prices — why pay more and get less? Write today for complete specifications, prices.

Modernair CORPORATION

Dept. C9, 400 PREDA ST., SAN LEANDRO, CALIF.

Member National Fluid Power Association 23

Circle 615 on Inquiry Card



How to THROW a FASTER PUNCH!

The aluminum cans shielding the R.F. coils we make for one of America's largest T.V. manufacturers need two clean holes punched on each side and one at the top. This was a wastefully time consuming job until we made the machine, shown above, to do the job automatically.

Now, thanks to Clippard Miniature Air Valves, Cylinders, Manifolds, Accessories and Fittings, used in the positions shown, we throw not only a FASTER punch, but a BETTER, CLEANER one!

Because of their versatility in control and work feeding operations, small size and ease of mounting, you, too, will find Clippard Miniature Pneumatic Devices useful in speeding production and improving quality of work. Keep an adequate supply in YOUR stockroom ready for immediate use! Write, NOW, for free literature and attractive prices.

DEALERS-DISTRIBUTORS: Write for attractive NEW sales proposition

Clippard INSTRUMENT LABORATORY, INC.

7380-A Colerain Road, Cincinnati 24, Ohio

Manufacturers of R.F. Coils, Electronic Equipment, Miniature Pneumatic Devices

Circle 616 on Inquiry Card

HERE'S HELP

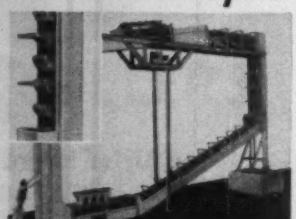
THAT SOLVES TROUBLESOME BULK HANDLING PROBLEMS:

Hapman

Tubular and Pivoted Bucket Conveyors

Hapman Tubular Conveyors move almost any bulk material—wet or dry—through any plane or angle. They're dust, liquid and odor-tight. Investigate!

WRITE for Bulletin T-A96.



Exclusive top loading device on Pivoted Bucket Carrier handles fragile materials gently. Many other unique advantages.

WRITE for Bulletin P-A96.

Hapman CONVEYORS, INC.

DIVISION HAPMAN-DUTTON COMPANY

KALAMAZOO MICHIGAN

In British Commonwealth & Europe: Fisher and Ludlow Ltd., Birmingham

Circle 617 on Inquiry Card

AUTOMATION

new books

MEASUREMENT SYSTEMS

By Charles S. Draper, head, Walter McKay, associate professor, and Sidney Lees, assistant professor, all of the Department of Aeronautical Engineering, Massachusetts Institute of Technology; 879 *pages,* 8½ *by* 11 *inches, illustrated, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from* AUTOMATION; $17.50 *postpaid.*

This book, Vol. 3, Part 1, of the work *Instrument Engineering,* is designed as a practical reference for engineers concerned with equipment of all degrees of complexity. Theory and applications of measuring systems are covered in this volume with sufficient repetition of fundamentals covered in preceding volumes to make this text quite self-contained. Illustrated tabular summaries cover information and components for mechanical, electrical, magnetic, electronic, and fluid systems.

AUTOMATION

By R. H. Macmillan, department of engineering, University of Cambridge; 100 *pages,* 4¾ *by* 7¼ *inches, illustrated, clothbound, published by Cambridge University Press, New York; available from* AUTOMATION; $1.95 *postpaid.*

The author is a graduate British engineer with teaching and lecturing experience. He has written in nontechnical fashion understandable to the man on the street. This introductory work surveys the development of automatic control and production and control system design problems. It also discusses automatic computers and the economics and effects of automation. The author also suggests further reading material on the subject.

ENGINEERING HANDBOOK

Edited by Jesse Huckert, professor of mechanical engineering, Ohio State University; 696 *pages,* 7 *by* 9¾ *inches, illustrated, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from* AUTOMATION; $12.00 *postpaid.*

An ASME handbook sponsored by the Metals Engineering Handbook Board of the American Society of Mechanical Engineers, this reference work is arranged in 15 sections presenting design standards, conversion data, and other engineering information needed in design calculations. Subjects covered include shafting, bearings, gears, cylindrical fits, keys, splines, bolts, nuts, springs, pipe, tubing, gaskets, packings and electric motors.

AUTOMATION

patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Data Processing

ELECTRONIC INFORMATION STORAGE DEVICES

A pickup plate is associated with an electric charge-retaining screen and a cathode ray tube. Charges are generated on specified areas by the cathode ray beam and a circuit coupled to the pickup plate effects an approximate integration of signals in the plate. Patent 2,749,439 by Frederic C. Williams, Tom Kilburn, Geoffrey C. Tootill, assigned to National Research Development Corp., London, England.

MAGNETIC STORAGE SYSTEMS FOR COMPUTERS AND THE LIKE

Channels of individually magnetizable cells on a drum are used to produce timing signals. A magnetic disk is rotated in timed relation to the drum and has a peripheral storage channel composed of individually magnetizable cells on which signals are recorded and retrieved under control of the timing pulses. Patent 2,739,299 by William H. Burkhart, assigned to Monroe Calculating Machine Co.

• • •

Machine Tools

MACHINE TOOL POSITIONING MECHANISM

A screw positions a machine element while a photoelectric cell scans a dial attached to the screw and an electronic counting device counts indicia on the dial as they pass the photoelectric cell. Patent 2,748,665 by Jurg A. Senn, assigned to Kearney & Trecker Corp.

PROCESS OF MACHINING

High production machining is effected by accurate shifting of a workpiece at rapid traverse rate to a working position, slowing the traverse rate to mill a surface, reestablishing the rapid traverse shifting and performing a broaching operation on the milled surface. Patent 2,747,271 by Emery C. Raehrs and William D. Averill, assigned to Cincinnati Milling Machine Co.

ESS Miniaturized ELECTRIC EYES

SPECIALLY DESIGNED FOR INDUSTRY

The ESS "miniaturized" photo-units (light source and pickup) are designed to fit into those small impossible places. These units are engineered for performance in **monitoring, counting, positioning, registration** and **density.**

ESS "miniaturized" electric eyes can easily be assembled on ¼" pipe and fittings.

For more than 20 years ESS instruments have been used by industry — indicators; recorders; and controllers for smoke, dust and turbidity, etc.

Don't Guess... SPECIFY ESS!

Write for information

ELECTRONIC INSTRUMENTS and CONTROLS for INDUSTRY TO KEEP OPERATIONS WITHIN LIMITATIONS

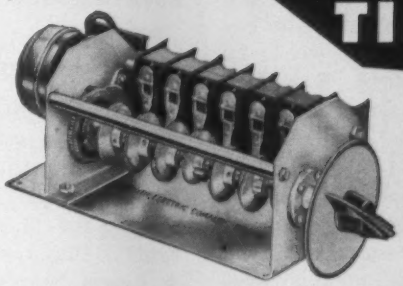
ESS INSTRUMENT COMPANY

96 SOUTH WASHINGTON AVENUE, BERGENFIELD 2, NEW JERSEY

Circle 618 on Inquiry Card

LONG LASTING! ACCURATE!

ZENITH Multi-Circuit CYCLE TIMER



for Automatic TIMING MIXING COMPOUNDING PROCESSING AND SIMILAR OPERATIONS

Zenith Multi-Circuit Timers are precision designed and built to accurately time any automatic operation, including appliances, commercial and industrial applications.

Can be set for on and off periods with as many circuits as desired. Furnished with or without synchronous motor for elevator control, limit switch and like operations.

AVAILABLE NOW IN ANY QUANTITY!

Write today for bulletin containing data on volts, cycles, circuits and prices.

See classified telephone directory for name of local distributor.

ZENITH ELECTRIC CO.

145 W WALTON ST. • CHICAGO 10, ILL.

Circle 619 on Inquiry Card

AUTOMATION abstracts

MANAGEMENT AND NUMERICAL CONTROL

By J. DAUGHERTY
Consultant
Hypro Products
Gidding & Lewis Machine Tool Co.

IN THE PAST TWO YEARS, a number of punched card, punched tape, and magnetic tape control systems for a variety of machines have made their appearance. A new form of machine control is coming into existence, aimed at applying automatic control to the production of parts produced in small quantities but involving complicated machining operations. These new systems differ from automation forms used in industries which operate at high volume. The high volume forms such as special machine combinations, transfer machines, etc., are engineered only once in several years.

Small quantity systems are more of the form of automatic machines using preset positioning devices, cam packages, templets and the like, where the setup may be revised every few days or weeks to produce different parts. Examples are automatic screw and chucking machines, automatic cycle milling machines, and templet controlled automatic machines. Numerical control systems are also included but have this difference: With the aid of electronics and memory systems, this new form of automation can be remotely set up, in fact can be engineered and stored in the memory package away from the machine. Almost any machine part can be produced automatically on a variety of servo-operated and memory controlled machines.

Systems for production of a variety of forms may be divided into two categories: (1) Those control systems for operations involving machine motions with independent position and discrete rate control; and (2) those systems requiring accurate variable rate and position control (variable path control). The first finds many applications such as drilling, boring, turning, etc. The second finds its field in those machining operations where continuous relative position of several machine members is imperative, such as profile milling, roll forming, spinning, etc.

These systems may again be subdivided into (a) those which propose having the memory means produced on the machine by operator control; and (b) systems which propose the preparation of the operating memory from engineering information by mathematical means. These last we call the numerical control systems.

Skills Necessary

This paper deals with the second division and subdivision (2b) and will discuss the development and location of engineering skills necessary for the successful operation of this system. The Giddings & Lewis Numericord System and the problems inherent in its use will receive primary consideration although all these systems are alike in general requirements, *Fig.* 1. At present this system finds its best field in the machining of aircraft components, skins, spars, ribs, bulkheads and the like.

Let us look at a flow chart of the present general method of processing a part from initial specification to finished stores. Specifically, we are interested in the point at which information and skill are stored and applied to originate, amend, modify, or correct the machining process, *Fig.* 2. Now look at a flow chart of the same part produced by automatic machines using numerical control, *Fig.* 3. In general the charts look the same. In Block *E*, of *Fig.* 2, the supervision, operation and the machine tool become the memory storage and incorporate the necessary skills to operate the machine. At this point, information can be amended, modified, or corrected to change the machining process. In Block *E* of *Fig.* 3 we notice that the storage of skills is complete at this point. The information is no longer subject to modification or change.

While this may seem unimportant, it can be the difference between success and failure. In today's systems, the methods men, time study men, tool engineers and material specification group supply only part of the information necessary to the successful processing of a part. A great deal of the final responsibility for accuracy lies with the shop supervision, operators and inspectors. These people provide a fund of knowledge gained in producing accurate parts with machines, tools and material that are far from ideal. It is the operator who corrects for deflection, distortion and wear. It is he who takes an extra cut when the material is too hard, or tools inadequate. These conditions must be eliminated or at least compensation supplied when using memory control.

It is not an exaggeration to say that to apply numerical control to today's machine would be to handicap a control process capable of extreme accuracy and ef-

ficiency with machines that fall short of this potential. To realize the full potential of the new control systems, machines with better servo systems are necessary; machines which incorporate the complete control within the feedback loop. Even these provisions are only partially satisfactory. Machines that are as free as possible from geometrical errors and which will maintain this relation under operating forces must be designed. The wear of bearing surfaces must be reduced and distortions due to temperature variations in the machine and workpiece must be corrected. Probably temperature controlled machines will be the answer.

Great strides have been made in the provision of better materials such as stretch leveled and stabilized rolled aluminum plate, straighter and more stable extrusions, and stress relieved forgings of more stable alloys. These materials will soon reach a uniformity to admit of automatic production processes.

Better servo systems are being developed to provide more accurate movement of machine members. Better power transmission systems are coming into being to reduce the inaccuracies in transmission of motion between the servo motor and the moving member. Improved bearings and better lubrication systems will retain the original performance of these improved machines. Improved chip handling and protection systems will save many hours of lost production time.

Major contributions to good performance are the new feedback systems which make it possible to control the exact position of the machine member insuring accurate performance of the machine to the command information. A number of new feedback systems are now available to supply accuracy to meet the needs of today's requirements.

To a great degree, the same information is necessary for a numerically controlled system as for a templet and tracer controlled system. The engineering necessary to define the tool path is approximately the same. In today's aircraft shops, a great many of these steps are performed graphically. However, as the numerically con-

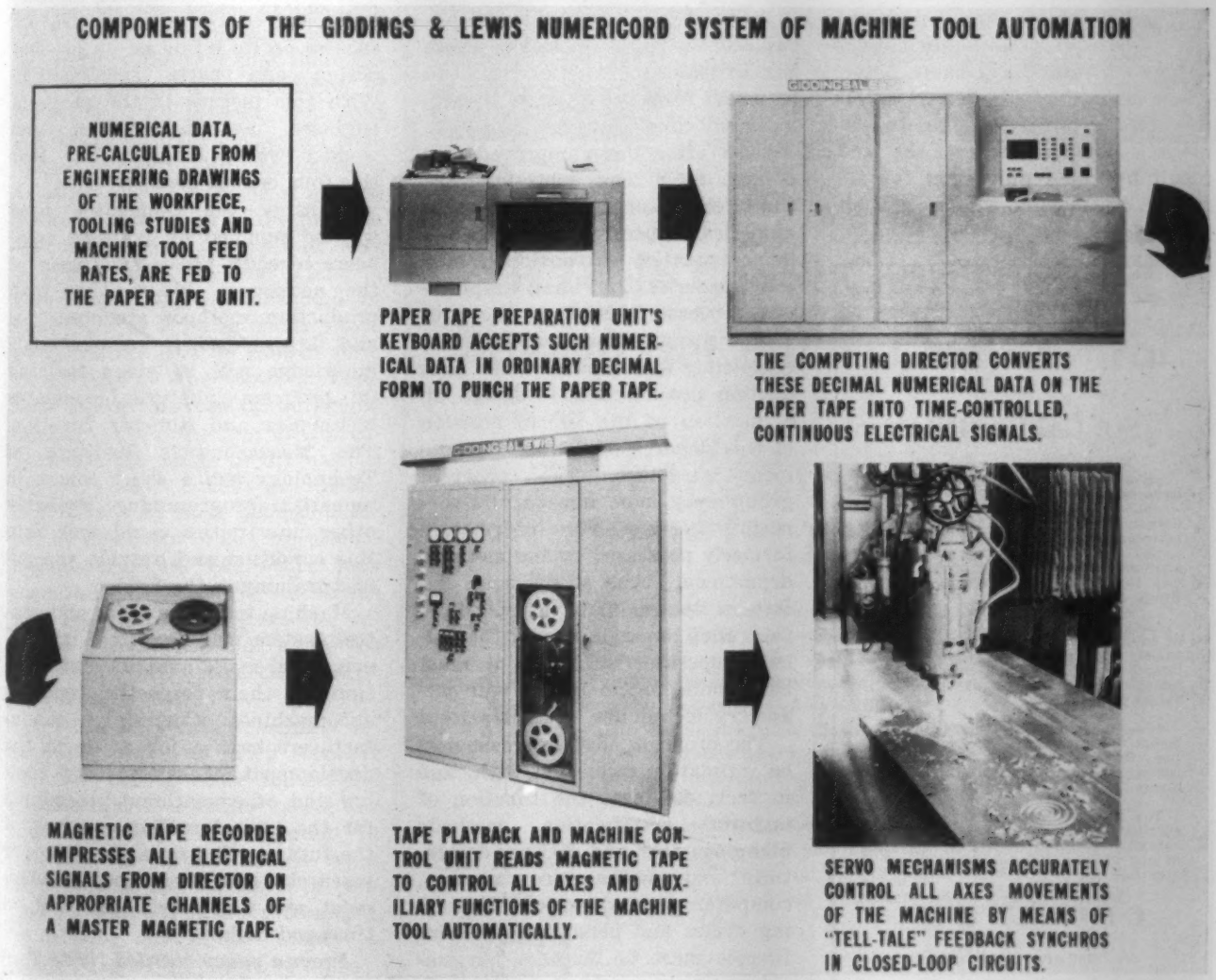

COMPONENTS OF THE GIDDINGS & LEWIS NUMERICORD SYSTEM OF MACHINE TOOL AUTOMATION
NUMERICAL DATA, PRE-CALCULATED FROM ENGINEERING DRAWINGS OF THE WORKPIECE, TOOLING STUDIES AND MACHINE TOOL FEED RATES, ARE FED TO THE PAPER TAPE UNIT.
PAPER TAPE PREPARATION UNIT'S KEYBOARD ACCEPTS SUCH NUMERICAL DATA IN ORDINARY DECIMAL FORM TO PUNCH THE PAPER TAPE.
THE COMPUTING DIRECTOR CONVERTS THESE DECIMAL NUMERICAL DATA ON THE PAPER TAPE INTO TIME-CONTROLLED, CONTINUOUS ELECTRICAL SIGNALS.
MAGNETIC TAPE RECORDER IMPRESSES ALL ELECTRICAL SIGNALS FROM DIRECTOR ON APPROPRIATE CHANNELS OF A MASTER MAGNETIC TAPE.
TAPE PLAYBACK AND MACHINE CONTROL UNIT READS MAGNETIC TAPE TO CONTROL ALL AXES AND AUXILIARY FUNCTIONS OF THE MACHINE TOOL AUTOMATICALLY.
SERVO MECHANISMS ACCURATELY CONTROL ALL AXES MOVEMENTS OF THE MACHINE BY MEANS OF "TELL-TALE" FEEDBACK SYNCHROS IN CLOSED-LOOP CIRCUITS.

Fig. 1—This block diagram indicates the main components of the new Giddings & Lewis Numericord System of machine tool automation. In operation, the Paper Tape Preparation Unit and the Computing Director, with its Magnetic Tape Recording Unit, are installed in a location remote from the machining area. Thus, magnetic-tape machining programs can be prepared on a production basis for all machines in the shop.

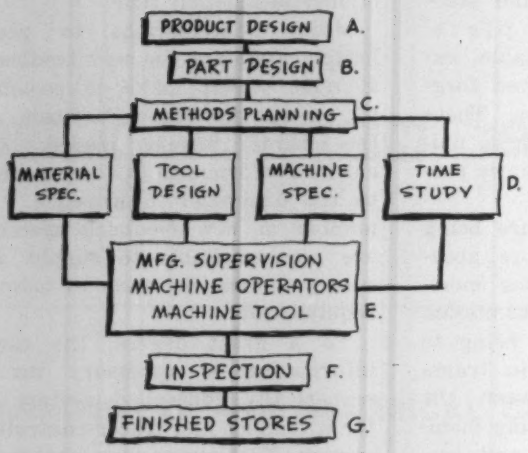


Fig. 2—Flow chart of present general method of processing a part.

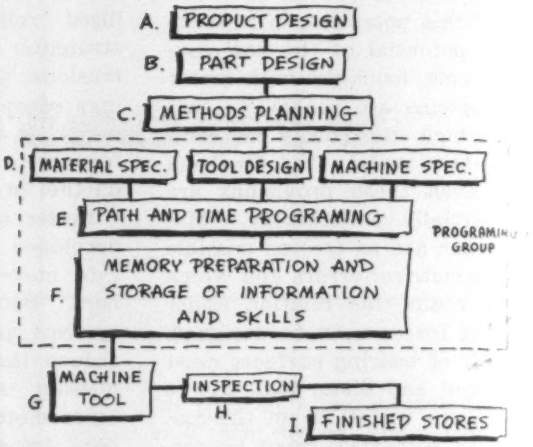


Fig. 3—Flow chart of part produced by automatic machines using numerical control.

trolled system makes possible increased accuracy of information storage and use, it seems unwise to use graphical analysis of the tool paths which would certainly carry initial errors. Mathematical analysis offers the greater possibility of producing the part specification accurately on the workpiece. However, where the end result has no requirement for accurate dimensional shape, graphical methods of analysis are certainly permissible. Even such systems as co-ordinate plotting of two or three-dimensional models to produce the necessary numerical information is possible where the original information may be in model form rather than mathematically dimensioned.

Even after these improved machines, tools and materials are available, the program group using numerical control still assumes a much greater responsibility for the completed part than in previous processes. In fact, the program group's responsibility so completely encompasses the production process that it brings up a question of the logical position of this department in the management structure. The program group must now have at its disposal the complete information formerly possessed by the methods department, time study, tool and fixture design, material specification, shop supervision and the machine operator. In fact, it must have more, as no longer will cut-and-try techniques be satisfactory.

The program engineer must now be intimately connected with, and in fact, dominate the function of material specification, methods planning, tool and fixture design, time and motion programming, computer techniques, manufacturing cycles and personnel. His influence must be dominant in machine purchase and fed back into product design and parts specification. Some organizations may elect to locate the program engineer in the manufacturing division, some in engineering, while others may create a separate department for this function.

Like all new production systems numerical control depends for its success on its influence on product design and parts specification. With this picture of the program engineer, we may pause and wonder where industry can find this four headed monster.

Probably the immediate need will be supplied by training engineers already possessing some of the necessary skills. Men with production, methods planning, tool and fixture design, and materials knowledge will be given training in program analysis, computer techniques and director function. The Massachusetts Institute of Technology has a short course in numerical programming. Probably other universities could look into this condition and provide specialized training in the field.

Machine tool companies and control system manufacturers will develop and make available information on their respective systems and machines. Cutting tool manufacturers have a job to do in the development of satisfactory tooling and of educational procedures for the use of tooling systems of the future. The rewards of proper research, education and development are well worth the cost in time and dollars.

From a paper entitled, "The Tool Engineer's Function in Numerical Control" presented at the annual meeting of the American Society of Tool Engineers in Chicago, March 1956.

Instrument Systems

ENGINEERING

in

SO. CALIFORNIA

Several qualified engineers and designers—electrical, chemical, mechanical—who are experienced in the design of instrumentation for the petroleum and petrochemical industries will find an opportunity to broaden their professional knowledge and experience in the Chemical Engineering Department of C F Braun & Co.

Assignments include the application of automatic control principles to a wide variety of plants ranging from complete integrated refineries and chemical processing centers thru all types of individual process units.

The work includes engineering and layout of instrument systems, the selection, specification and inspection of components, and startup of completed plants.

Top salaries, fine facilities, profit-sharing retirement plan and other major company benefits. Write to the head of our Personnel Department, Mr. F B Stratford.

C F BRAUN & CO.

Alhambra, California

Established 1909

Engineers

Consultants **Constructors**

Circle 620 on Inquiry Card

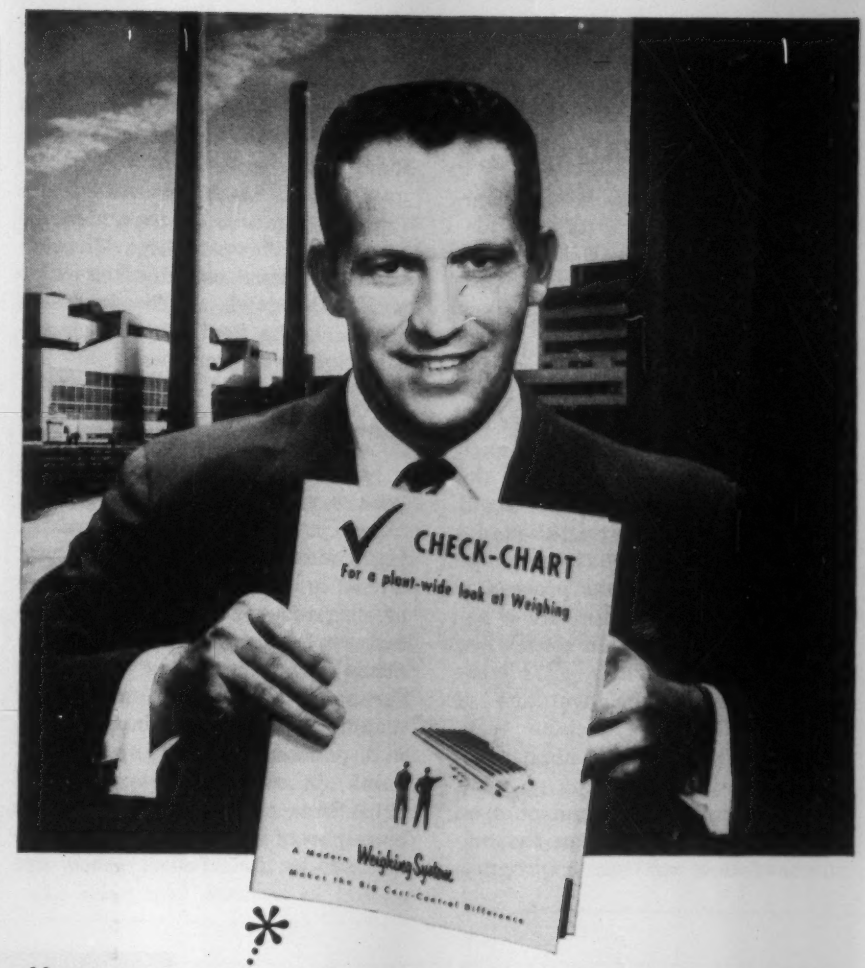
INDUSTRY NEEDS AUTOMATION

By ALLEN V. ASTIN
Director
National Bureau of Standards

AUTOMATION has been receiving more and more publicity in recent years. It seems to have caught the fascinated interest of the general public, of labor and management groups, and even of Congressional Committees. And I must admit it has been a subject of great interest to me and to many of the staff of the National Bureau of Standards.

Now each of these interested groups has approached automation from a different point of view. And in many cases there has been a certain amount of confusion or misunderstanding about what is meant by the term, automation. Part of the confusion, I believe, stems from the fact that there exists no agreed upon definition of the term. At present, the word has many meanings. They all have this in common—automation seeks to eliminate the number of manual operations required in the processing of materials, data or devices. But they differ in the extent to which such operations should be eliminated and the extent to which machines are used to control actual processes. For some, automation means the use of automatic devices for the transfer of a product from one stage to the next in an operation. Others go further and include in their definition the use of machines to control mechanized operations. Still others look upon automation as a technique whereby machines serve to increase the efficiency of a process and, at the same time, the number of items produced.

I think automation includes all of these ideas and much more. It includes, among other things, the substitution of machine power for muscle power, the delegation to machines of certain limited types of decisions, the technique of continuous measurement or sampling by sensing devices, the ability to change any or all phases of a process as a result of machine analysis and control, the continuous maintenance of equipment, the automatic management of supply and



"This Scale Check Chart showed us how to get Better Cost Control"

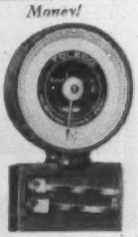
It's New from TOLEDO—send for yours today!

Your scales are a vital element in effective cost and quality control. Errors in weighing go all the way through accounting and affect cost . . . profit . . . or loss! You need to look at *all* your weighing today . . . not as isolated scales, but as a *weighing system.*

Toledo's new Scale Check Chart will show you quickly and accurately how well your scales are serving you, and provide the information you need for truly effective cost control.

This new Check Chart is yours for the asking in a handy kit that contains all you need for an easy, informative appraisal of weighing in your plant. Send for it today. Address Toledo Scale Company, 1415 Telegraph Rd., Toledo 1, Ohio.

On Your Scales... Material Becomes Money!



TOLEDO®
HEADQUARTERS FOR SCALES

Circle 621 on Inquiry Card

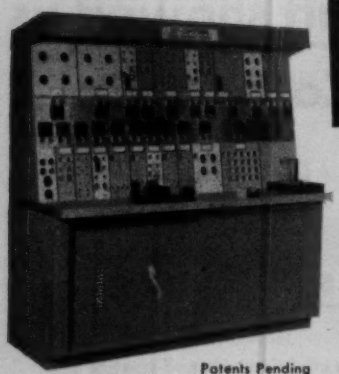
inventory, and, to carry automation one step further, the use of automatic electronic data processing equipment to relate plant production to accounting and management processes.

Last winter I spoke before members of the communications industry. At that time I told them that what is popularly termed an automatic factory was partially a misnomer. What I told that group, I believe, still stands. Most of the factories which are called automatic are merely advances over the continuous production plants such as those which have existed in the flour milling industry for about 100 years. These production plants do have the virtue that they take the raw material and process it through various stages into a finished product. In this sense they are automatic. Their production processes all take advantage of modern advanced machine techniques. They depend almost entirely for their operation on what might be called command or open circuits. By this I mean the machines follow an initial program which has been devised for the machines. The machines merely imitate the orders all along the way. In general, feedback is not used in these processes. Thus, modern industry still depends, to a large degree, upon machines which are rigidly programmed to undertake certain specific operations. The controls for these machines are also rigidly designed. These processes still lack the flexibility which automation can give them.

Automation in Electroplating

Now let me apply what I have been saying to the electroplating industry. I note that in recent years there have been significant advances in the mass production of electroplated materials, particularly in the use of transfer mechanisms to move these materials through the various tanks for pickling, cleaning, rinsing, plating, and polishing. Such progress, I think, is most important, but I think it is only a beginning. The concepts of feedback and flexible control, in their fullest sense, are still not an important part of this production. Let me explain further by these examples.

There is still no mechanism which examines every item to insure that it has been cleaned and readied for plating, and more than this to decide whether an alteration in the process should be made. There is no electronic device that will analyze the various factors needed for an optimum plating bath in relation to the item which is being plated. There are almost no devices in production use which will insure the continuous and uniform thickness of a coating. I have been told that in the plating of wire, a device is in use which will measure the thickness of a coat and that the result of such measurement will be used automatically to control the speed with which the wire is drawn through the bath. This, on a very limited scale, is one of the types of automatic controls which must be used more extensively if the electroplating industry is to take greater advantage of the opportunities of automation.



CY-CO-TROL

Tool Control Units

Patents Pending

Reduce Production Costs on All Machines with Multiple Tooling!

cyclometers give you positive control of tool life

Keep your machines operating at top capacity . . .

Helps eliminate down-time for machine adjustments . . .

standard and special gages used for all tool lengths

Eliminate trial runs . . .

Reduce your tool breakage and costly rejects . . .

Many of our Units are now in use throughout the Automotive and Metalworking Industries.

Write for additional information and catalog

ROYAL design and manufacturing, inc.

4133 E. TEN MILE RD., CENTERLINE, MICHIGAN

Circle 622 on Inquiry Card

Automatic BAR UNLOADER

Another SPECIAL UNIT by FEEDALL

This versatile unit will unload bars or tubing from a production machine and place them in tote boxes—Capacity 3 ft. to 12 ft. long and 1½" to 3" in dia.—Eliminates one manual handling of parts.

FEEDALL Engineers will be glad to work with you to perfect automatic feeders or unloaders to simplify your production cycle.

Write for information advising purposes for which you need automatic equipment.

FEEDALL INCORPORATED WILLOUGHBY, OHIO

Circle 623 on Inquiry Card

It would be difficult for me to predict the manner and the extent to which the newer automatic techniques will eventually be applied to the electroplating industry. This depends upon a whole host of factors. Some of these are technical, that is, relating production requirements to specially devised instrumentation and computational controls. Others are economic and psychological. One has to overcome certain natural inclinations to do things in accepted ways. And one has to evaluate the fiscal problems involved in reorganizing a production scheme so that automatic processes can be introduced. And it must be remembered that it takes time to prove in and debug a new system. Eventually I think such automatic techniques will come into use.

As far as I know, there is no industry which cannot profit by further mechanization and automation, and most industries, excepting perhaps some petroleum and chemical processing plants, have not even taken advantage of the automatic control devices which are now in existence. There are some industries which have recognized the great possibilities offered by these devices. The increased use of transfer mechanisms and automatic polishing, cleaning, and plating subassemblies in electroplating is a good example of this awareness. But the use of automatic control devices is still lagging, and, in some cases, quite a ways behind the available technology.

Data Processing

Another aspect of automation which is not directly related to production but which has an important effect upon the total business operation is that of automatic data processing. Here there are a number of advances which have been made. Any production operation must be accompanied with a significant amount of paper work. This is the nature of modern business. Production is of itself dependent upon various outside factors. Among these may be included management decisions, accounting, inventory, sales, billing, payroll, shipment, the varying cost of raw materials, and the analyses of marketing conditions. In any big business, this may amount to a sizable proportion of the staff, a large volume of paper handling, and a constant need for making decisions of various kinds.

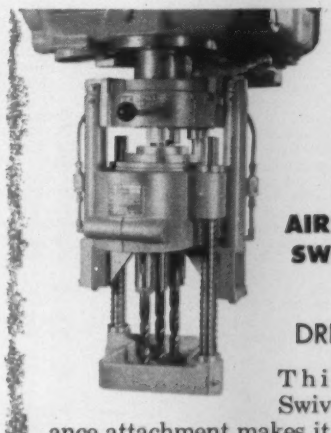
Now some or all of these factors may be automated. The use of automatic data processing machines can be made to serve in two ways. In the first case, they can be used to take on many of the routine and burdensome tasks, and they can do these with high efficiency and speed. In the second case, they can be used to bring together and digest a large number of varying pieces of information which will enable management to make more rational decisions and in sufficient time to affect the operation. Once again, I must warn that it is not an easy job to shift over to automatic data processing. The same obstacles which existed in automatizing production exist here, but even more so.

Nevertheless the promise for automation is indeed good, and I do not believe that any obstacles will have any success in holding back the general progress towards making increased use of automatic techniques. I believe that we are beginning to witness a new type of Industrial Revolution, one which exceeds by far the promise of the revolution of the Seventeenth and Eighteenth Century.

From an address entitled, "Process Control Through Automation" presented to the American Electroplaters Society in Washington, June, 1956.

POSITION AVAILABLE

Field Engineer for Automatic Strapping Equipment. We are expanding our line of steel strapping machinery and need a young man to assist in application engineering and eventually to assume sales and service responsibility in a midwest territory. Engineering training and strapping sales experience desirable. Write General Strapping Corporation, Mr. M. N. Ripley, 100 Park Avenue, New York, N. Y.



New

AIR COUNTERBALANCE SWIVEL ATTACHMENT

FOR RADIAL DRILLING MACHINES

This new combination Swivel and Air Counterbalance attachment makes it possible to adapt large multiple spindle drill and tapping heads to radial drilling machines. Flexible and easily adjusted, it insures maximum safety for the operator, as well as better operating economy.

Attachment includes air filter, pressure regulator, and an air oiler, and incorporates a 360° swivel feature fully aligning the drill head. It operates equally well with the fixed center type head and the adjustable type head.

This package is ideally suited for drilling condenser plates, boiler tube sheets, flue sheets, etc.

Manufacturers of all types of Fixed Center, Adjustable, and Individual Lead Screw Tapping Heads

US DRILL HEAD

THE UNITED STATES DRILL HEAD COMPANY

BURNS STREET • CINCINNATI 4, OHIO

Circle 624 on Inquiry Card

CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Acceleration, dc motors, 6-82
Accounting, 4-118, 130
  materials handling, 5-112
Air contamination control, 5-52
Alder, S. M.
  Magnetic Memory Controls Distribution Conveyor, 7-69
Aluminum,
  anodizing, 6-66
  melting, 6-66
Ammunition boxes, 4-44
Analog computers, 5-108
Analog to digital converter, 6-19
Analysis, electric circuit, 8-122
Analyzers, continous, 8-49
Anodizing, 6-66
Arcwelding, 4-59
Assembly, 6-12, 17
  auto wheels, 9-40
  circuit board, 5-34
  electronics, 4-21
  springs, 4-57
Atwood, P. F.
  Integrating Springmaking, 4-57
Automatic multispindle machine tools, 6-49
Automation,
  and government, 7-28
  and industry, 7-28
  and labor, 5-10; 7-28
  and the public, 7-28
  and stockholder, 7-28
  apprenticeship program, 7-19
  controllers, 9-54
  effects of, 6-142
  for electronics, 5-34
  in Russia, 5-13
  machine tool field, 5-19; 8-66
  philosophy, 6-12, 46; 7-28
  planning for, 4-35; 7-28
Automobile crankshaft turning, 5-66
Automobile frame manufacture, 4-58
Automobile parts manufacture, 8-55
Automobile wheel assembly, 9-40
Automotive data processing, 5-115
Award, editorial, 6-11

B

Bakery, handling, 6-24, 32, 34
Balancing,
  automatic, 9-71
  flywheels, 7-13
Barnes, D. E.
  Transistor Utility Improves, 4-117
Barrel finishing, 6-142
Batch processing, 6-58
Batching, 4-73
Baughman, G. W.
  Automatic Operation of Railroads, 8-116
Bearings,
  antifriction valve, 9-70
  synthetic fiber, 7-13
Beer-case handling, 8-37
Belt feeders, 7-37
Bending, tubing, 4-58
Bibliography, servomechanisms literature, 4-107
Binary,
  device, 5-116
  operation, 6-60
Black, D. V.
  Bibliography of Literature on Servomechanisms, 4-107
Bolz, R. W.
  It's Not Automatic, edit. 9-39
Bracking, dc motors, 6-82
Brazing, 4-14
Bronze, continuous casting, 7-42
Brown, W. B.
  Efficient Induction Heater, 5-57
Buchsbaum, W. H.
  Automation Right Now, 6-46
Bulk weighing, 8-44
Burgoyne, A. S.
  Synchronizing Sensing and Processing, 9-49
Bus bars, 6-16

C

Cable conveyors, 6-76
Cameras, 8-16
Carbon paper manufacture, 6-46
Cards, control, 5-116
Carrier equipment, remote control, 9-66
Carton, slitting, 5-117
Casting, continuous, 7-42
Ceramics, spray system, 8-20
Chemical,
  handling, 6-28
  pneumatic & electronic controllers, 9-54
  processing, 4-130; 8-49
Chip removal, 6-21
Circuits,
  assembly of, 5-34
  preferred, 7-49
  self-checking, 8-10
  standardized, 6-11; 7-49
  tester, 6-19
Cleaning, 7-52
Closed-loop, systems, 7-56
Coal handling, 6-28, 37
Code, systems, 4-36
Coffee, dispensing machine, 6-12
Coffman, P. A., Jr.
  Controlled Feeding For Liquid And Dry Materials, 7-37
Coil,
  slitting, 4-58
  stock processing, 6-77
Combes, J. J.
  Continuous Analysis Key to Improved Processing, 8-49
Common language, 4-68
Components, 5-116; 6-138; 8-30
Computers, 4-12, 68, 126; 5-120; 6-134
  analog, 5-108
  and management, 8-122
Container, slef-feeding, 7-20
Contents, 9-3
Continuous melting furnace, 6-65
Continuous processing, 6-58
  of fiberboard, 6-68
Continuous stream processing, 8-49
Continuous strip processing, 6-46, 77
Contour forming, 8-41
Control, 5-116; 6-138; 7-55; 8-120
  aircraft throttle, 8-19
  bulk feeders, 7-37
  business, 4-68
  chemical processes, 4-130; 8-49
  conveyor, 5-49; 7-69; 8-37
  cupola operation, 5-52
  cutoff operation, 5-48
  dc drive, 8-60
  electric motors, 4-46
  electrical, 4-36, 53
  electronic, 6-46
  electropneumatic, 5-48
  feedback systems, 6-60, 77, 142
  food packaging, 9-46
  grain feeding, 4-52
  grinding operation, 8-13
  hydraulic, 4-126
  instrument, 4-53
  machine, 9-71
  machine tools, 5-48; 8-66
  milling, 6-60
  numerical, 6-60
  of railroads, 8-116
  panelboard drilling, 5-10
  pH, 9-78
  photoelectric, 4-126; 8-41
  plating system, 5-70
  pneumatic, 4-53, 126
  press, 4-51
  process, 6-52; 7-46
  relay systems, 4-36
  self checking, 8-10
  signals, 4-46
  solid state, 7-113
  speed, 4-46; 8-110
  strip processing, 6-77
  system design, 8-122
  tape, 5-26; 7-66; 8-115
  temperature, 8-8
  template, 8-41
  water works, 6-46
Controllers, 4-46; 9-54
Converters, analog to digital, 6-19
Conveying, 8-37
  skip hoist, 4-73
  wiring boards, 5-34
Conveyors, 4-58, 127
  automatic unload and transfer, 9-44
  escapement, 9-41
  gravel, 8-12
  gravity wheel, 6-50
  helicoidal screw, 7-68
  light product, 7-61
  overhead, 6-25, 30, 38
  overhead cable, 6-76
  pneumatic, 6-24, 28, 34; 8-44
  tiered, 6-58
Cost,
  direct and indirect, 5-112
  materials handling, 5-112
Counting, 4-51
  instruments, 6-11
Covered rolls, 6-75
Crystals, quartz, 4-75
Cupola installation, 5-52
Current limit, dc motors, 6-82
Cutoff machine, 5-48
Cycle, automatic machine, 8-55

D

Data processing, 4-12, 16, 68, 120; 5-115, 116; 6-142; 7-10, 11; 8-37
Data storage, 7-46
Davis, R. E.
  Testing Hydraulic Speed Control, 8-110
Dc drives, 8-60
De Carlo, C. R.
  Uses of Computers In Production, 6-134
Delays for information, 9-49
Design,
  control system, 8-122
  electronic, 8-30
  electronic circuits, 5-34
  hydraulic, 7-23
  plating systems, 5-67
  systems with actuating devices, 5-60
Detector,
  overheat, 5-12
  tear, 6-46
Differential transformer, 8-13
Digital computers, 7-128
Dinsmore, R. P.
  What's in the Record?, 4-121
Direct costs, 5-112
Direct current motors, 4-46
Dispensing, 4-126
  coffee machine, 6-12
Distribution, 6-24
  system, 7-69
Downtime, 4-58
Drives, dc, 8-60
Dryer, air, 4-12
Dynamic costing, 5-112

E

Economics, 4-75, 118
Editorial award, 6-11
Electric circuit analysis, 8-122
Electric-pneumatic transmitters, 4-53
Electrical,
  bus bars, 6-16
  circuit tester, 6-19
  control, 4-36
  transmitters, 4-53
Electrohydraulic handling control, 8-55
Electrohydraulic system, 6-73
Electron tube, 4-19
Electronics,
  accounting, 4-130
  automation for, 5-34
  cantrol, 4-36; 6-46; 9-54
  in business, 7-128
  modular design, 6-12
  parts assembly, 4-22
  process control, 6-52
  rectifier, 4-46
  reliability of, 6-142; 8-30
  standardization, 7-49
  transformers, 4-130
Electropneumatic control, 5-48
Electrostatic paint spraying, 8-46
Elevator conveyor, 8-54
Ellis, W. R.
  Automation for Electronics, 5-34
Embossed, wiring, 5-34
Enamel porcelain, 8-46
Engineering for automation, 8-29
Engineers and automation, 6-41
Engineers, professional,
  considerations, 5-120
Ensign, G. G.
  Watch Automation, 6-131
Equations for computers, 5-108
Etched wiring, 5-34

F

Faulkner, W. H.
  Radiation Gaging of Plastic Sheet, 6-77
Feedback, 4-46, 52; 6-60
  in continuous thickness gaging, 6-77
Feeders, 5-57; 8-48
  hydraulic, 6-73
  magazine, 6-73
Feeding, 4-14; 8-25
  bulk materials, 7-37
  dry foods, 9-46
  electronic components, 5-34
  grain, 4-52
  long parts, 6-49
  press brake, 8-41
  screws, 4-22
Fiberboard manufacture, 6-68
Finishing, 4-58; 8-46
  barrel, 6-142
Fixtures, 5-19
Flash welders, 4-58
Flow measurement, 4-53
Flowmeter, 4-127
Food packaging, 9-46
Food processing, 7-61
Forecast, 4-68
Forging, 6-22; 7-68
  heater, 5-57
  machining, 9-64
  press, 4-11
Foundry, 4-73; 5-52
  handling, 6-22, 27
Frames, automobile, 4-58
Freezing food items, 7-61
Furnaces,
  arc, 7-42
  continuous casting, 7-42
  continuous melting, 6-65
  normalizing, 7-10
Furniture, anodizing aluminum, 6-66

G

Gaging, 6-14, 128; 8-48
  for machine tools, 8-66
  radiation, 6-77
  sheet thickness, 6-77
  strip width, 5-117
Gas fired furnace, 6-65
Grain grinding, 4-52
Graphite, dies in continuous casting, 7-42
Gravimetric feeders, 7-37
Gravity wheel conveyors, 6-50
Greenley, H. R.
  Auto Wheel Assembly, 9-40
Grinding,
  centerless, 6-22
  grain, 4-52
  machines, 6-73
Gunfire control, 4-12

H

Handling, 4-14, 127; 5-67; 6-21, 139; 7-32; 8-120
  between presses, 8-55
  coal, 6-28, 37
  conveying, 5-49; 6-21, 50, 76; 7-69; 8-44, 54
  feeding, 5-117; 6-49; 7-68
  foundry, 6-28
  in plating, 7-52
  in press operations, 7-63
  mechanism design, 5-60
  paper, 6-21, 32, 38
  sand, 4-73
  stone, 9-70
Hansen, L. D.
  Tape Control of Circuit Testing, 5-26
Harder, D. S.
  Manufacturing in the Future, 8-115
Hardy, C. L.
  Warehousing in Steel, 4-119
Heat pump system, 7-9
Heating, 5-57
  without fuel, 7-9
Helicoidal screw conveyors, 7-68
Hoppers, 8-25
Horsepower, dc motors, 6-82
Hosmer, R.
  Automatic Transmitting Elements, 4-53
Hunt, J. A.
  Automatic Actuating Devices, 5-60
Hydraulics, 7-23
  control, 8-55
  machine tool, 8-12
  press, 8-41
  speed control, 8-110
  torque motor, 6-38

I

Indexing, 8-66
Indexing table, 6-73
Indirect costs, 5-112
Induction heating, 5-57
Information,
  delays, 9-49
  handling, 4-68
In-process gaging, 6-128
Inspection, 6-14
  visual, 5-59
  x-ray, 4-11
Instruments, 4-53
  counting, 6-11
  liquid weight measuring, 8-13
  radiation gaging, 6-77
Integrated handling, 6-21
Interfloor conveyors, 8-54
Inventory control, 7-10

J

Jaeger, J. J.
  Automation Affects Quality Control, 7-116
Jay, J. B.
  Automation Actuating Devices, 5-60
Johnson, E. C.

Numerically Controlled Milling, 6-60

K

Keebler, J. C.
Making Automobile Frames, 4-58
Knitting machines, 6-46

L

Landsness, C.
Automatic Balancing, 9-71
Lapping, wafer, 4-75
Lawson, C. J.
Standardization of Electronics, 4-122
Levin, H. S.
Automation Spurs the Changing Office, 4-68
Linking devices, 5-60
Logic circuit, 7-113
Loss-in-weight feeders, 7-37

M

Machine tools, 4-127; 5-19
automated types, 8-66
bar automatics, 6-49
control, 8-13
crankshaft turnings, 5-66
cutoff machine, 5-48
drilling, 5-10
gaging, 6-128
grinder, 6-73
hydraulic, 7-23
hydraulic slotter, 8-12
milling, 6-60
Machines, 8-121
assembly, 5-34; 6-12
balancing, 9-71
coffee dispensing, 6-12
design, 7-128
developed from match industry, 5-31
food packaging, 9-46
knitting, 6-46
mounting, 7-63
sawing, 5-12
wax making, 6-58
Macmillan, R. H.
Control Systems Simplified, 7-55
Magazine feed, 5-34; 6-49
Magnetic amplifier, 5-120
Magnetic memory units, 7-69
Magnetic tape, 7-69
Magnets, 4-20
manufacture, 8-48
Maintenance,
electronic, 8-30
support program, 7-10
Manufacture of,
air frames, 8-41
ammunition boxes, 4-44
appliance parts, 8-46
automobiles, 8-25
automobile frames, 4-58
automobile parts, 6-22, 41
automobile wheels, 8-55
axle housings, 7-32
bread, 7-61
cams, 6-60
camshafts, 6-22
carbon paper, 6-46
coil springs, 7-68
compounded chemicals, 8-44
crankshaft forgings, 6-22
dog food, 8-14
electronic assemblies, 5-34
electronics, 4-122
fiberboard, 6-68
flywheels, 7-13; 9-71
matchbook covers, 5-31
mercury batteries, 6-12
motors, 6-76; 7-63
office furniture, 6-66
permanent magnets, 8-48
plastic sheet, 6-77
printed circuits, 8-19
quartz crystals, 4-75
sparkplugs, 6-42
office furniture, 6-66
stampings, 8-55
toothbrushes, 6-50
transistors, 5-9; 7-11
TV components, 8-54
valves, 9-64
watches, 6-131
wax cakes, 6-58
wiring boards, 5-34
Manufacturing prediction, 8-115
Manufacturing research, 8-25
Materials,
handling, 4-118, 119; 5-112; 8-37, 54
Mathematics 5-120
McKeown, G. E.
Radiation Gaging of Plastic Sheet, 6-77
McRainey, J. H.
Relay Control Systems, 4-36
Measurement, 4-53
Measuring, 4-127; 5-117
liquid flow by weight, 8-13
speed, 4-127
x-ray inspection, 4-127
Mechanisms, 5-120
actuating devices, 5-60
Melting, continuous furnace, 6-65
Memory units, 7-69
Menard, C. G.
Evaluating Machine Tool Arrangements, 8-66
Mercury batteries, manufacture of, 6-12
Metallurgy, 5-120
Microscope, in gaging, 6-14
Milek, J. T.
Bibliography of Literature on Servomechanisms, 4-107
Milham, R.
Automatic Transmitting Elements, 4-53
Milling machine,
numerical control, 6-60
tape control, 7-66
Mixing, dry, 8-44
Modular design of electronics, 6-12
Mohler, J. B.
Automatic Plating Installations, 5-67
Continuous Casting of Bronze, 7-42
Controlling p*H* of Process Solutions, 9-78
Monitor vibration, 8-22
Motor,
dc, 6-82
electric, 4-46
generator, 4-46
hydraulic or pneumatic, 6-38
manufacture, 6-76; 7-63
synchronous induction, 5-10
Muller, D. C.
Magnetic Memory Controls Distribution Conveyor, 7-69
Mullin, W. C.
Automatic Gaging for Machine Tools, 6-128
Mulling, 4-73
Murphy, V. R.
DC Drive Characteristics, 6-82
Elements of Speed Control, 4-46
Selection of DC Drives and Controls, 8-60
Muther, R.
Line Production Savings, 6-133

N

Nitka, N. J.
Testing Hydraulic Speed Control, 8-110
Nothman, G. A.
Tools of Automation, 7-120
Numerical control, 6-60

O

Office automation, 4-68; 7-128
Office furniture manufacture, 6-66
Operational equations, 5-108
Operations research, 4-68, 75
Overhead conveyors, 6-25, 30

P

Packaging, 6-21; 8-14
dry foods, 9-46
Paint spraying, 8-46
Painted wiring, 5-34
Painting, 4-58
Pallets,
handling, 8-54
loading, 5-49; 8-37
Panelboard drilling, 5-10
Paper handling, 6-21, 32, 38
Peterson, K. W.
Electronics for Process Control, 6-52
p*H*, control of, 9-78
Pharmaceuticals, 4-16
Philosophy,
automation, 6-12
machine tool development, 5-19
Photocell,
control, 8-41
scanning, 6-46
Pickling, 4-16
Piercing, 4-58
Pipe, manufacture, 7-46
Planning, 4-35
Plant layout, 6-133; 7-63
Plastic sheet manufacturing, 6-77
Plated wiring, 5-34
Plating, 4-14; 5-67; 7-52
handling, 6-25
Pneumatic,
actuating devices, 5-60
assembly machines, 5-34
communication tubes, 8-37
controllers, 9-54
conveying, 6-24, 28, 34; 8-44
feeding devices, 7-68
operation, 4-36
torque motor, 6-38
transmitters, 4-53
Porcelain enamel, 8-46
Post-process gaging, 6-128
Pressed powder wiring, 5-34
Presses, 7-32
brake, 8-41
continuous fiberboard, 6-68
forging, 4-11
Pressure measurement, 4-53
Printed circuits, 5-34, 120; 8-19
Process control, 4-130
electronic, 6-52
Process, 4-53
controllers, 4-53; 9-54
development, 8-25
planning, 4-75
Processing,
batch and continuous, 6-58
chemical, 8-49
Processing of strip stock, 6-77
Product design, 5-34; 6-26
Production,
line, 6-133
scheduling, 6-134
Projection welders, 4-58
Proportioning, 4-73
Punch presses, 4-58
Punched cards, 7-13
assembly, 5-47
Punched tape, 5-26
control, 6-60

Q

Quality control, 7-115
relay circuits, 5-26
Quartz crystal, 4-75

R

Radiation gaging, 6-77
Radio, weather station, 6-15
Railroad, 8-116
car identification, 4-11
signal systems, 4-36
Recuperative hot blast system, 5-52
Redner, K. H.
Packaging Dry Food Products, 9-46
Refinery, 4-12
Regulation dc motors, 6-82
Regulator, voltage, 5-12
Relays, 4-36
automatic circuit testing, 5-26
Reliability, electronic, 8-30
Remote control, 6-52
via voice frequencies, 9-66
Remote monitoring, 4-53
Research, 8-25
Resistors, temperature sensitive, 9-69
Reynolds, H. L.
Photocells Control Versatile Press Brake, 8-41
Rolls, covered, 6-75
Russian automation, 5-13

S

Sampling, chemical, 8-49
Sand handling, 4-73
Saunders, B. W.
Handling Costs in Materials Handling, 4-118
Saw, wafer, 4-75
Sawing, fiberboard sheets, 6-68
Scanning, photoelectric, 6-46
Scheduling production, 6-134
Scollard, W. E.
Auto Wheel Assembly, 9-40
Scrap disposal, 7-63
Screw feeding, 4-22
Seam welders, 4-58
Selection of dc drives, 8-60
Semi-conductor, thermistor, 9-69
Serrating, 6-49
Servomechanisms, bibliography, 4-107
Shafting, flexible, 3-41
Shipping, 8-37
Signal systems, 4-36
Small plant automation, 5-60
Smart, W. L.
Porcelain Enamel Applied Electrostatically, 8-46
Smith, C. E.
Sealed Cupola Installation, 5-52
Soldering, automatic, 5-34
Solid state controls, 7-113
Solution, p*H* control, 9-78
Solvent refining, 4-12
Sorting, 8-48
Spark plug manufacture, 6-42
Special machinery, 8-29
Speed,
adjustment, 6-82
control, 5-10; 8-110
Spray system, ceramics, 8-20
Springs, 4-57
Stacker, tubing, 4-58
Stadum, C. B.
How to Use Solid State Controls, 7-113
Stamped wiring, 5-34
Stamping, 7-32, 63; 8-55
press, 4-51
Standardization, 4-122
Standardized circuits, 6-11; 7-49
Standards, electrical, 7-128
Statistics, 4-75
Steady state, 8-110
Steel, pickling, 4-16
Storage, 6-26
Swartz, D. M.
Management — Sell Automation, 7-28
Switching, railroad, 8-116
Synchronization, dc motors, 6-82
System reliability, electronic, 8-30
sorting, 3-64
Systems,
control, 7-55; 8-122
relay control, 4-36
traffic control, 4-36

T

Tandem operation dc motors, 6-82
Tapes,
advantage of paper, 5-26
control, 5-26; 6-60; 7-66; 8-115
feed, 5-34
magnetic, 7-11
preparation, 7-66
steel control, 8-41
Tear detector, 6-46
Television, 4-11
in gaging, 6-14
Temperature,
measurement, 4-53
movement, 7-11
Testing,
circuits, 5-34; 6-19
keyboard operated equipment, 7-10
motors, 7-63
relay circuits, 5-26
speed control, 8-110
vacuum seal, 6-139
Textiles, knitting machine controls, 6-46
Thermistors, 8-8; 9-69
Thermostat, overheat detector, 5-12
Threading, 6-49
Timing, 4-51; 9-49
Torque motor, 6-38
Toothbrush manufacture, 6-50
Traffic control, 4-36; 5-16
Training, 6-142; 7-128
Transducer, 6-52
Transfer,
machines, 5-19; 8-66; 9-64, 74
mechanism, 4-127
Transformer, electronic, 4-130
Transient response, 8-110
dc motors, 6-82
Transistors, 3-11; 4-117; 5-9; 7-128
manufacture, 7-11
Transmitting elements, 4-53
Tubes,
electronic, 4-19
mills, 4-58
Tucker, D. P.
Reliability of Electronic Equipment, 8-30
Turning, 6-49

U

Ultrasonic cleaning, 5-10
Urano, A. S.
Automatic Controls in Pipe Production, 7-46

V

Vibration monitor, 8-22
Vibratory feeding, 4-12; 8-48
Visual inspection, 5-59
Voice frequency carriers, 9-66
Voltage regulator, 5-12

W

Wafer, crystal, 4-75
Waldron, A. J.
Weigh the Advantages of Pneumatics for Process Control, 9-54
Walter, L.
Fiberboard Manufacture, 6-68
Ward-Leonard system, 4-46
Warehousing, 4-119; 5-49; 6-24; 8-37
Water works controls, 6-46
Wax molding, 6-58
Weather station, 6-15
Web,
inspection, 5-59
position control, 4-126
Weighing, 4-73; 5-117
bulk, 8-44
system design, 3-44
Welding,
flash, 4-58
projection, 4-58
projection and seam, 4-44
seam, 4-58
Winding machines, 4-126
Wire belt conveyor, 6-24, 32
Wise, L. V.
Using Operations Research in Process Planning, 4-75

X

X-ray, inspection, 4-11, 127